

Speculum Nauticum.

A Looking-Glass FOR SE A-MEN.

Wherein they may behold, how by a small
Instrument, called the PLAIN SCALE, all
Nautical Questions, and Astronomical Propositions,
are very easily and demonstratively performed.

First set forth by *John Aspley*, Student in Physick, and
Practitioner of the Mathematicks in *London*.

The NINTH EDITION.

Whereunto are added many new Propositions in
Navigation and Astronomy; and also a third Book, shew-
ing a new way of Dialling. With an Appendix contain-
ing the Use of all Instruments that are used at Sea.

By *H P.* and *W. L.*

2.

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Nov 9 1898



Percy Chase fund

SEAMEN.

Which may be held by a small
instrument called the Pearl Seal and
which is a small instrument in the hand

and is a small instrument in the hand
and is a small instrument in the hand

THE EDITOR

Whereas are added many new propositions in
navigation and sailing and also a small book of
instructions for the use of the Pearl Seal and
the use of the Pearl Seal and the use of the Pearl Seal

By the Editor

1. The use of the Pearl Seal and the use of the Pearl Seal
2. The use of the Pearl Seal and the use of the Pearl Seal
3. The use of the Pearl Seal and the use of the Pearl Seal

TO THE
WORSHIPFUL,
THE
MASTER, WARDENS & ASSISTANTS
OF THE
TRINITY HOUSE;
JOHN ASPLEY,
IN
TESTIMONY OF THE HONOUR
HE BEARS TO THE
GOVERNOURS and PRACTICERS
OF THE ART OF
NAVIGATION,
DEDICATES THESE HIS
FIRST LABOURS.



The Stationer to the Reader.

THis little Book having been well accepted of among
Sea-men, being the first-fruits of Mr. Aspley's Ma-
thematical Studies, passed six Impressions without any
alteration; and so I doubt not might have done still:
But because since that time there have been several Books put out
of this nature, I have procured this to be revised, And several
Alterations and Additions, to be made therein: So that here you
have both the old, and a new Book intermingled all in one, with
a third part added thereto, concerning Dialling, by a way not for-
merly published by any. All which I doubt not you will kindly
accept of, and receive much delight and profit thereby.

Yours,

B. H.

OF THE ART OF

~~NAVIGATION~~

INDICATES THESE HIS
FIRST LABOURS.



Speculum Nauticum,
OR,
THE SEAMANS
GLASS.

The First Book,

CHAP. I.

The Explanation of certain Terms of Geometry.



Being intended in this Treatise of the plain Scale, to declare the manner of projection of the Sphere, *in plano*, I have thought fitting, first to shew unto you some terms of Geometry, which are necessary for the unlearned to know, (for whose sake chiefly I write this Treatise) before they enter into the definition of the Sphere.

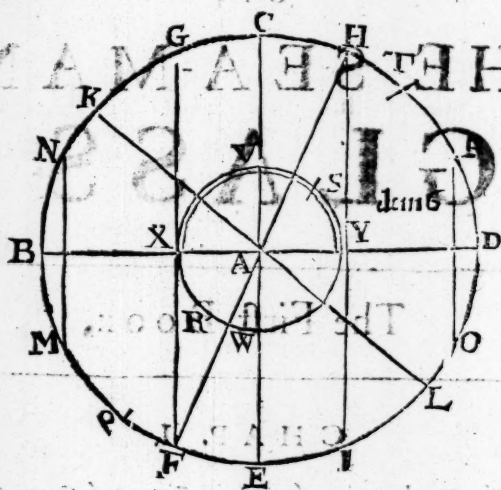
First therefore I intend to relate unto you, what a Point or Prick is,
B and

The Sea-mans Glas.

and afterward a Line both right and crooked, and such forts thereof as are appertinent unto the operations and use of this scale.

Punctum, or a Point, is the beginning of things; or a Prick supposed indivisible, void of length, breadth, and depth: as in the Figure following is noted by the point or prick A.

Linea, or a Line, is a supposed length, or a thing extended in it self in length, not having breadth nor thickness, as is set forth unto you by the Line B A D.



Parallela, or a Parallel Line, is a Line drawn by the side of another Line, in such sort that they may be equidistant in all places. And of such parallels, two only belong unto this work of the plain Scale, that is to say, the right-lined Parallel, and the circular Parallel.

Right-lined Parallels are two right lines equidistant one from another, which being drawn forth infinitely, would never touch or meet one another, as you may see in the Figure, where the line H I is parallel unto the line C E, and the line G F is parallel unto them both.

The Sea-mans Glaſs.

A circular Parallel is a circle drawn either within or without another circle upon the ſame center, as you may ſee plainly by the two circles BCDE, and XYYW. Theſe circles are both drawn upon the center A, and therefore are parallel the one unto the other. There is another kind of Parallel alſo, which is called a Serpentine Parallel, but becauſe it is not belonging unto the uſe of this Scale, I will omit it, and ſo proceed unto the reſt.

Perpendicularum, or a Perpendicular, is a line raiſed from, or let fall upon another line, making equal Angles on both ſides, as you may ſee declared in the Figure, wherein the line AC is perpendicular unto the line BAD, making equal angles in the point A.

Diameter circuli, or the Diameter of a Circle, is a right line drawn thorow the center of any circle, in ſuch ſort that it may divide the circle into two equal parts, as you may ſee the line BAD is the Diameter of the circle BCDE, becauſe it paſſeth thorow the center A, and the two ends thereof do divide the circle into two equal parts in the two extreames B and D, making the ſemicircle BCD equal unto the ſemicircle DEB.

Semidiameter circuli, or the Semidiameter of a circle, is half of the Diameter, and is contained betwixt the center, and the one ſide of the circle, as the line AD is the Semidiameter of the circle BCDE. This Semidiameter contains 60 degrees of the line of Chords; which we ſometimes call the Radius.

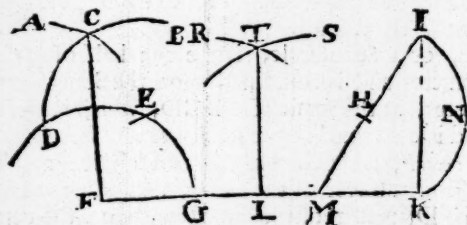
Semicirculus, or a Semicircle, is the one half of a circle drawn upon his Diameter and is contained upon the Superficies or Surface of the Diameter, as the Semicircle BCD, which is half of the circle BCDE, and is contained above the Diameter BAD.

Quadrans circuli, is the fourth part of a circle, and is contained betwixt the Semidiameter of the circle, and a line drawn perpendicular unto the Diameter of the ſame circle from the center thereof, dividing the Semicircle into two equal parts, of the which parts the one is the Quadrant, or fourth part of the ſame circle. As for example, the Diameter of the circle BCDE is the line BAD, dividing the circle into two equal parts: then from the center A raiſe the perpendicular AC, dividing the Semicircle likewise into two equal parts; ſo is ABC, or ACD, the Quadrant of the circle BCDE, which was deſired.

C H A P. II.

The manner how to raise a Perpendicular from the middle of a line given.

Draw first a ground line whereupon you would have a Perpendicular raised, then open your Compasses unto any distance (so it exceed not the end of your line) placing one foot of the said Compasses in the point from whence the Perpendicular is to be raised, and with the other foot make a mark in the line on both sides, then removing your Compasses unto any other distance that is greater, set one foot thereof in one of the marks, and with the other foot make an arch over the middle point; then with the same distance of your Compasses set one foot in the other mark upon the line, and with the other foot make another arch of a Circle over the middle point, so that it may cross the first arch; and from the meeting of these two arches, draw a right line unto the middle point, from which the Perpendicular was to be raised, which line shall be the Perpendicular desired.



Example. Suppose your base or ground line whereupon a Perpendicular is to be raised, be the line F L K, and from L the Perpendicular is to be raised, set one foot of your Compasses in the point L, and with the other make the marks G and M on both sides of the point L; then opening your Compasses wider, set one foot in the point M, and with the other draw the arch S over the point L, then

The Sea-mans Glasse

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then with the same distance of your Compasses, set one foot in G, and with the other make the arch R, crossing the arch S in the point T, then from T draw the line TL, which line is perpendicular unto the line FLK from the point L, which is the Perpendicular desired.

CHAP. III.

To let a Perpendicular fall from any Point assigned, unto the middle of a line.

Let the line whereupon you would have a Perpendicular let fall, be the line FLK, and the point assigned to be the point T, from whence you would have a perpendicular let fall upon the line FLK; first set one foot of your Compasses in T, and open your Compasses unto any distance, so that it be more than the distance TL, which here we suppose to be the distance TM; then make in the line FLK, the marks G and M, then with your Compasses take the one half of GM, which is the point L, then from L draw a line unto the point T, so the line TL shall be the Perpendicular which was desired to be let fall from the assigned point T, unto the middle of the line FLK.

CHAP. IV.

To raise a Perpendicular upon the end of a Line.

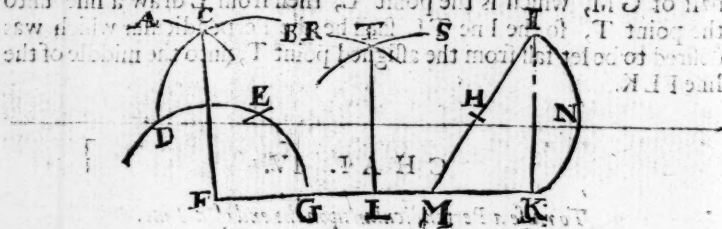
Suppose the line whereupon you would have a Perpendicular raised, be the line FLK, and from the point of F a Perpendicular is to be raised: first open your Compasses unto any distance, which here we put to be the distance FG, and set one foot of your Compasses in the point F, and with the other draw the arch DEG, then set one foot of your Compasses in the point G, and with the other draw the arch E; then placing one point of your Compasses in E, with the other draw the arch DB; then place your
Compasses.

Compasses in D, and with the same distance draw the Arch A, cutting the Arch D B in C, then draw a line from C unto the end of the line FLK, unto the assigned point F, so shall the line CF be a perpendicular raised from the end of the line FLK, and from the assigned point F.

CHAP. V.

To let a Perpendicular fall from any point assigned, unto the end of a Line.

Let the line FLK be the Base or ground line, and from the point I a perpendicular is to be let fall upon the end of the line at K, first from the assigned point I, draw a line unto any part of the Base, which shall be the line IHM, then find the middle of the line IM, which is at H; place therefore one foot of your Compasses



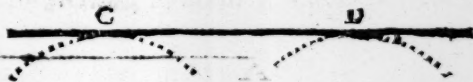
in the point H, and extend the other unto I, with which distance draw the Arch INK upon the center H, cutting the Base or ground line in the point K, then draw the line KI, which line shall be the Perpendicular desired.

CHAP. VI.

A right line being given, how to draw another parallel thereunto at any distance required.

Let the line given be AB , unto which it is required to draw another right line CD which shall be parallel to the former line AB and at the distance AC .

First open your Compasses to the distance AC , then set one foot in the point A , with the other describe the Arch C ; Again, place one foot in B , and with the other describe the Arch D .



Then draw the line CD so that it may only touch the two Arches C and D , so shall the line CD so drawn, be parallel to AB , and at the distance required.

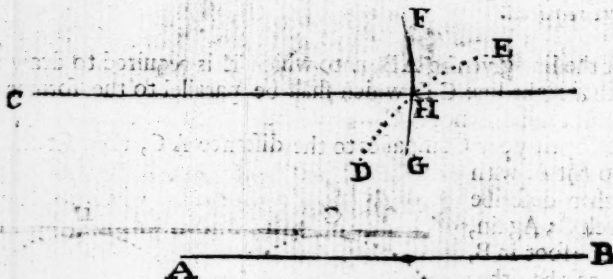
CHAP. VII.

A right line being given, how to draw another parallel thereunto, which shall also pass through a point assigned.

Let AB be a line given, and the point assigned be C ; and let it be required to draw another line parallel thereunto, which shall pass through the given point C .

First, Take with your Compasses the distance from A to C , and placing one foot thereof in B , with the other describe the Arch DE , then take in your Compasses the whole line AB , and placing one foot

foot in the given point C, with the other foot describe the arch F G, crossing the former arch D E in the point H. Lastly, if you draw the line C H, it shall be parallel to A B.

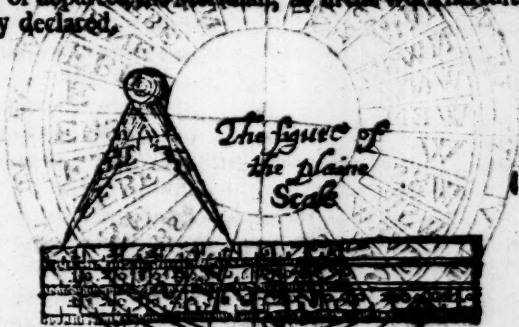


NOW I doubt not but you understand the way to let fall or to raise any manner of Perpendicular line, either from, or upon any part of a line; as also to draw lines parallel one to another at any distance required: therefore now I intend to proceed unto the main point here aimed at, which is, to declare and make known unto you the several operations performed by the plain Scale, which though it be in use with very few, yet it is most necessary for Sea-men, because all questions in Navigation are thereby easily and plainly wrought. And also all questions in Astronomy (belonging unto the expert and industrious Sea-men) may both speedily and easily be wrought by the same Scale: in regard whereof I have declared in this little Book that knowledge (which God hath been pleased to bestow upon me) concerning the necessary use and practice thereof; hoping that you will as kindly accept it, as it is freely offered unto your courteous considerations.

CHAR. VIII

Of the Description of the Scale.

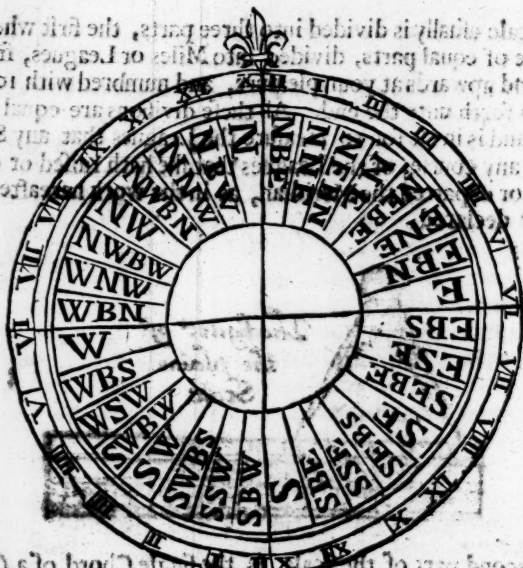
THis Scale usually is divided into three parts, the first whereof is a Scale of equal parts, divided into Miles or Leagues, from 1 unto 100. and upwards at your pleasure, and numbred with 10, 20, 30, 40, and so forth unto the end. All these divisions are equal unto one another, and is in use for to measure the Leagues that any Ship hath run, upon any course, or the Leagues that she hath raised or depressed the Pole, or departed the Meridian, as in the work hereafter shall be more fully declared.



The second part of the Scale, is the single Chord of a Circle, or the Chord of 90, and is divided into 90 unequal divisions, representing the 90 degrees of the Quadrant: and are numbred with 10, 20, 30, 40, &c. unto 90. This Chord is in use to measure any part or arch of a Circle, not surmounting 90 degrees: The number of these degrees from 1 unto 60 is called the Radius of the Scale, upon which distance all circles are to be drawn, whereupon 60 of these Degrees are the Semidiameter of any Circle that is drawn upon that Radius.

The third part of the Scale is divided into eight parts, representing the Points or Rumbs of the Mariners Compas; which in all
C are

are 32 points: . but upon the Scale there are only 8 reckoned, which is but one Quadrant or quarter of them, being to be reckoned from the Meridian of North and South both ways, as you see more plainly by this Figure, representing the order of the points of the Compass.



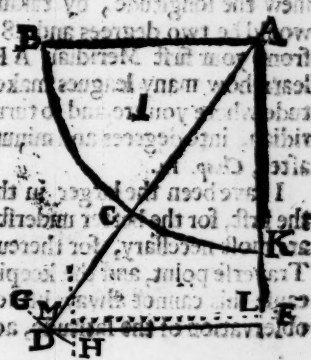
It is usual also to have another line placed upon your Scale, to show you how many leagues make a degree of longitude in every latitude. Concerning which you shall have directions in the 14 Chapter following.

CHAP.

Knowing the course any Ship hath made, and the leagues she hath sailed: to find how much she hath raised or depressed the Pole, and likewise how much she is departed from her first Meridian.

The course is South-west and by South, the Leagues sailed are 100, the difference of the Latitude, and the distance of the Meridian is required.

IN the first demonstration, first draw the line **AB**, and from the center **A**, let fall the perpendicular **AF**, which represents the Meridian; then opening your Compasses unto the Radius of your Scale, set one foot thereof in the Center **A**, and with the other draw the arch **KCB**: then in regard your Course is South-west and by South, that is, three points from the South, take three of the eight points of the Compass with your Compasses out of your Scale, and place them from **K** to **C**; then draw the line **A C D**, which represents the Rumb or point of the Compass you have sailed upon; then cut off your Scale of leagues, take with your Compasses the number of leagues you have sailed upon this course, which is 100



leagues, and place them upon the Rumb line **A C D**, from **A** to **D**, crossing the line **A C D** at the end thereof with the arch **G D H**: then from the point **D**, draw the line **D F** parallel to the line **A B**, so it will cut the Meridian line **A K F** in the point **F**.

Now you must heedfully observe this point **D**, for this represents the place where your Ship is, and doth shew both the difference of the latitude of the place you are in, and also your distance or departure from your first Meridian.

First for the latitude, You see the line **D F**, being parallel to the line

line A B, cuts the Meridian line A F in the point F: So that if you take the distance F a with your Compalles, and apply it to the scale of equal leagues, you shall find it is just 8; leagues, which counting 20 leagues to a degree, makes 4 degrees 0 min. and so much you have altered your latitude by the said course; which degrees and minutes being added to, or subtracted from the latitude of the place you came from, according as your course requires, shews you always the true latitude you are in.

Likewise from this point D, take with your Compalles the distance D F, and you shall find it by your scale of equal leagues to be 56 leagues; and so much you are departed from your first Meridian to the Westward: which when you are near the Equinoctial, where the degrees of longitude are equal to the degrees of latitude, would shew the longitude, by taking 20 leagues for one degree, &c. So it would be two degrees and 8 min. for your difference of longitude from your first Meridian A F. But in other places you must first learn how many leagues make a degree of longitude about that latitude where you are, and so turn your leagues of distance from the Meridian, into degrees and minutes of longitude: of which more hereafter, *Chap. 12.*

I have been the larger in these two Propositions, because they are the first, for the better understanding of all the rest; And because they are most necessary, for thereupon depends the knowledge of the true Traverse point, and the keeping of your dead reckoning. Now because this cannot always be kept exactly, it is to be corrected by the observation of the latitude, according to this following Proposition.

CHAP.

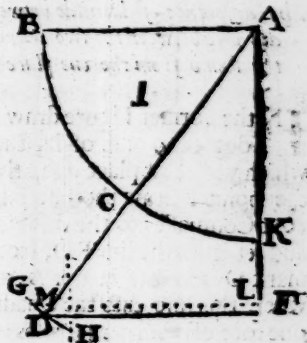
CHAP. X.

Knowing the difference of latitude of two places, and the Rumb you have sailed upon, to find the leagues you have sailed, and the difference of Meridians.

The Pole depressed four degrees, and the Rumb South-west by South, or the third from the Meridian, to find your true Traverse point, viz. how far you have sailed, and how much you are departed from your first Meridian.

In the first Figure.

Draw the lines as in the former Chapter, so that A K F may represent the Meridian line, and A C D may represent the third Rumb from the Meridian; then because you have altered your latitude 4 degrees, which make 80 leagues, take 80 leagues with your Compasses out of your scale, and set them upon the Meridian line A F, from A to L: Then keeping the same distance of your Compasses, draw the line L M parallel to A B (or else you may erect L M perpendicular to the line A F, in the point L) and mark where the said L M crosseth the Rumbline A C D, which is in the point M. This point M is the true Traverse point, the leagues sailed are shewed by the line A M, which being measured in the scale, will be found to be 96 leagues and an half; and the departure from the Meridian is L M, which is 54 leagues.



Now by this Proposition (as I said) you may correct your dead reckoning; for suppose by the former proposition you reckon you had sailed 100 leagues upon the third Rumb, then as you see there, you should have been at the point D, and have altered your latitude 83 leagues.

83 leagues, and departed from your Meridian 56 leagues; but now suppose that by a good observation of the latitude, you find that you have altered the latitude only 80 leagues from A to L, by drawing the line LM, which crosseth the Rumb or Ships way in M, you may conclude your true traverse point to be at M, so that you have sailed only from A to M, which is 96 leagues $\frac{1}{2}$, and departed from your Meridian 54 leagues. So that as you are short of the latitude you reckoned for, 3 leag. or 9 min. you are also short of your way you reckoned 3 leag. $\frac{1}{2}$, and 2 leagues less in your departure from the Meridian. And this you must account for your true reckoning, being thus corrected.

C H A P. XI.

By the difference of the latitudes of two places and the distance between their Meridians, to find the Rumb by which you must sail from the one place to the other, and how far it is from one place to the other.

The difference of latitude between the two places is 4 deg. 9 min. and the distance between the two Meridians is 56 leagues, and is required to find the Rumb from the one place to the other.

IN the former Figure draw the Quadrant A C B, then turn your 4 degrees 9 min. of latitude into leagues, it maketh 83 leagues, which you must place upon the Meridian line from A to F. And from the point F draw the line F D parallel to the line A B. Then open your Compasses to the distance of the Meridians, which is 56 leagues, and set it on the line F D, from F to D. Then lay your Ruler by this mark D and the center A, and draw the line A C D. Then mark where this line cuts the Quadrant, which is in the point C, and setting one foot of your Compasses in the point C, open the other to K, and keeping your Compasses at that distance C K, measure it upon your Scale, either in the line of Chords, or in the line of Rumbs, you shall find it to be in the one 33 deg. 45 min. and in the other just the third Rumb from the Meridian. So that the Rumb from A to D is South-west and by South, and the Rumb from D to A is the Rumb opposite thereunto, which is North-east and by North.

Then

Then for the distance, between the two places in the Rumb, set one foot of your Compasses in the one place at A, and open the other to the other place at D, and the length of the line AD measured in the Scale of leagues, shews the distance between them to be just 100 leagues.

These three (or rather these six) Propositions, (for they are each of them double) are the most useful and necessary in the Art of Navigation. By the first of these, knowing the point of the Compass you sail upon, and judging how many leagues you have sailed thereon, you know and are able to give a reasonable account where you are, both in respect of latitude and longitude. By the second, having a fair observation of the latitude at any time, you may more perfectly know where you are; and thereby correct your former account. And by this third you may know how to direct your course from any place to your desired Haven. So that in effect you need no more, but yet for your better instruction by variety of cases and examples, I shall proceed.

CHAP. XII.

The difference of latitude and the leagues sailed being given, to find the distance from the Meridian, and the Rumb you have sailed upon.

Sailing 100 leagues between South and West, until the Pole be depressed 4 deg. 9 min. the distance from the Meridian is demanded, and what Rumb you have sailed upon?

IN the first figure draw the Quadrant AKCB, as in the former Chapters, and then reduce your degrees of latitude into leagues, so 4 deg. 9 min. make 8 $\frac{1}{2}$ leagues; which you must take with your Compasses out of your Scale of leagues, and set them off in this Meridian line from A to F. Then from the point F draw the line FD, parallel to the line AB, which you may do with the foresaid distance of your Compasses. Then open your Compasses unto your distance sailed, which is 100 leagues, and setting one foot of your Compasses in the point A, with the other draw the little arch

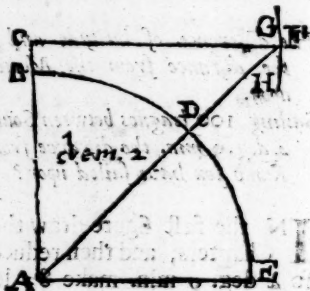
arch HG , cutting the line FD in the point D . So the line FD meaſured in the ſcale of leagues, ſhall ſhew you the diſtance from the Meridian, which is 56 leagues: if you draw the line ACD , it is the Rumb line upon which you have ſailed, and the arch KC meaſured in the ſcale of Rumbs, ſhews it to be the third Rumb from the Meridian, or South-weſt by South.

CHAP. XIII

To find the diſtance of any Iſland from you, that you may diſcern at two ſtations, knowing the point of the Compaſs, the Iſland beareth unto each of the ſtations.

Suppoſe, being at Sea you diſcover an Iſland bearing North-eaſt off you, which place let be your firſt ſtation; and then ſailing ſeven leagues full North, you obſerve the Iſland to bear full Eaſt off you, which let be the ſecond ſtation; the demand is to find the diſtance of the ſaid Iſland from both the ſaid ſtations?

IN the ſecond Figure, or demonſtration, let A be the firſt Station, and upon the Center A draw the Quadrant $ABDE$; Then in regard you found the Iſland to bear North-eaſt from you, take four of your eight points of the Compaſs out of the ſcale, and place them upon your Quadrant from B to D , then from the Center A by the point D , draw the line ADF , representing the viſual line paſſing between your ſight and the Iſland, being at the firſt ſtation A . Then ſeeing when you had ſailed 7 leagues North, you obſerved the Iſland to bear full Eaſt off you, ſet off the ſaid ſeven leagues from A to C , (reckoning every 10 leagues of your ſcale to be but one) and from this point C , which is the ſecond ſtation, draw the line CF parallel



to A E, and it will cut the line A D F in the point F: so shall the point F be the place of the Island desired, and the distance A F, is the distance of the Island from the first station, viz. 9 leagues 90 parts or almost 10 leagues: Likewise the distance from C to F is the distance of the Island from the second station, which is just 7 leagues. And by this manner of work, you may find the distance of any Island or head-land from you, or you may take the distances of as many places as you will or can see at two such stations, and by the crossing of their visual lines, find their position and distances each from other.

CHAP. XIV.

To find how many leagues, miles and parts, do make every degree of longitude in every latitude.

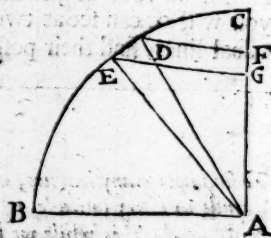
Note, All this while we have been sailing according to the Rules of the plain Chart, which supposeth the degrees of longitude to be equal to the degrees of latitude, in all latitudes, but that is very false, and erroneous; it being true only in places near the Equatorial, where every degree of longitude contains 20 leagues, but the degrees of latitude do; But in places near the Poles it alters very much, so that in the latitude of 60 degrees, 20 leagues make a degree of longitude, and in other latitudes the degrees of longitude alter, as in this little Table, which sheweth at what degree and minute of latitude, how many leagues make a degree of longitude, by which you may divide a Line upon your Scale for your ready use.

Leagues in one degree.	20	00 d	00 m	Leagues in one degree.	10	60 d	00 m
	19	18	11		9	63	15
	18	25	50		8	66	25
	17	31	47		7	69	31
	16	36	52		6	72	32
	15	41	25		5	75	31
	14	45	34		4	78	28
	13	49	27		3	81	22
	12	53	08		2	84	16
	11	56	38		1	87	8

Now to return to the Question, and shew you by demonstration how to find how many leagues, miles and parts, make a degree of longitude in any degree of latitude?

TAKE 60 parts out of your Scale of equal parts, which you must reckon for miles, and count three of them to a league, and therewith draw the Quadrant ABC, then from the point B, set off the degree of the latitude proposed (which for example, let it be 58 deg. 54 min.) from B to D, then from the point D draw the line DF parallel to AB, so shall the length of this line DF, being measured in your Scale of leagues, shew you the number of leagues and miles, which answer to a degree of longitude in the said latitude of 58 deg. 54 min. which you shall find to be 31 miles, or 10 leagues and one mile. So also BE being the arch of 51 deg. 35 min. the line EG shews one degree of longitude to be 37 miles, or 12 leagues and one mile.

The larger you make your Quadrant, the more exactly will the work be, and shew the leagues and miles more exactly, which you may make into a Table, as this following.



Latitude	Distance of one degree of longitude in miles	Distance of one degree of longitude in leagues
0	69.16	23.05
1	69.17	23.05
2	69.18	23.06
3	69.19	23.06
4	69.20	23.07
5	69.21	23.07
6	69.22	23.08
7	69.23	23.08
8	69.24	23.09
9	69.25	23.09
10	69.26	23.10
11	69.27	23.10
12	69.28	23.11
13	69.29	23.11
14	69.30	23.12
15	69.31	23.12
16	69.32	23.13
17	69.33	23.13
18	69.34	23.14
19	69.35	23.14
20	69.36	23.15
21	69.37	23.15
22	69.38	23.16
23	69.39	23.16
24	69.40	23.17
25	69.41	23.17
26	69.42	23.18
27	69.43	23.18
28	69.44	23.19
29	69.45	23.19
30	69.46	23.20
31	69.47	23.20
32	69.48	23.21
33	69.49	23.21
34	69.50	23.22
35	69.51	23.22
36	69.52	23.23
37	69.53	23.23
38	69.54	23.24
39	69.55	23.24
40	69.56	23.25
41	69.57	23.25
42	69.58	23.26
43	69.59	23.26
44	69.60	23.27
45	69.61	23.27
46	69.62	23.28
47	69.63	23.28
48	69.64	23.29
49	69.65	23.29
50	69.66	23.30
51	69.67	23.30
52	69.68	23.31
53	69.69	23.31
54	69.70	23.32
55	69.71	23.32
56	69.72	23.33
57	69.73	23.33
58	69.74	23.34
59	69.75	23.34
60	69.76	23.35

A Table

The Sea-mans Glaſs.

19

A Table ſhewing how many leagues, miles and hundred parts of a mile make one degree of longitude in any latitude.

Latitude	Leagues	Miles	Parts	Differ.	Latitude	Leagues	Miles	Parts	Differ.	Latitude	Leagues	Miles	Parts	Differ.
0	20	0	0	—	30	17	0	96	—	60	10	0	0	—
1	19	2	99	1	31	17	0	43	53	61	9	2	9	91
2	19	2	96	3	32	16	2	88	55	62	9	1	17	92
3	19	2	92	4	33	16	2	32	56	63	9	0	24	93
4	19	2	85	7	34	16	1	74	58	64	8	2	30	94
5	19	2	77	8	35	16	1	15	59	65	8	1	36	94
6	19	2	67	10	36	16	0	54	61	66	8	0	40	96
7	19	2	55	12	37	15	2	92	62	67	7	2	44	96
8	19	2	42	13	38	15	2	28	64	68	7	1	47	97
9	19	2	26	16	39	15	1	63	65	69	7	0	50	97
10	19	2	09	17	40	15	0	96	67	70	6	2	52	98
11	19	1	90	19	41	15	0	28	68	71	6	1	53	99
12	19	1	69	21	42	14	2	59	69	72	6	0	54	99
13	19	1	46	23	43	14	1	88	71	73	5	2	54	100
14	19	1	22	24	44	14	1	16	72	74	5	1	54	100
15	19	0	96	26	45	14	0	43	73	75	5	0	53	101
16	19	0	68	28	46	13	2	68	75	76	4	2	52	101
17	19	0	38	30	47	13	1	92	76	77	4	1	50	102
18	19	0	06	32	48	13	1	15	77	78	4	0	48	102
19	18	2	73	33	49	13	0	36	78	79	3	2	45	103
20	18	2	38	35	50	12	2	57	79	80	3	1	42	103
21	18	2	1	37	51	12	1	76	81	81	3	0	38	104
22	18	1	63	38	52	12	0	94	82	82	2	2	35	103
23	18	1	23	40	53	12	0	13	83	83	2	1	31	104
24	18	0	81	42	54	11	2	27	84	84	2	0	27	104
25	18	0	38	43	55	11	1	44	86	85	1	2	23	104
26	17	2	93	45	56	11	0	55	86	86	1	1	18	104
27	17	2	46	47	57	10	2	68	87	87	1	0	14	104
28	17	1	98	48	58	10	1	80	88	88	0	2	09	104
29	17	1	84	50	59	10	0	90	90	89	0	1	05	104
30	17	0	26	51	60	10	0	96	96	90	0	0	0	104

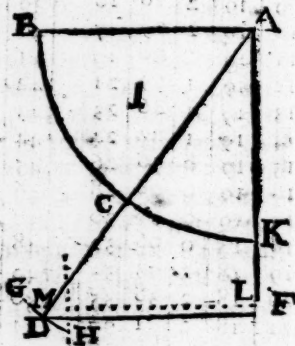
CHAP. XV.

The difference of latitude, and the Rumb or distance sailed being known, to find the distance of the Meridians, and thereby to find the degrees and minutes of the difference of longitude in any latitude.

Sailing from the North Parallel of 56 degrees and 5 min. latitude, 100 leagues upon the third Rumb from the Meridian, viz. South-west and by South, until I find the Pole is depressed 4 degrees 9 minutes, and the Meridional distance 56 leagues; the longitude is desired thereby?

In the first Figure.

Draw the Quadrant as is shewed before, then reduce your 4 degrees 9 min. of latitude into leagues, it makes 83 leagues, which set off upon the Meridian Line from A to F. Then upon the Rumb line ADC set off the distance sailed from A to D, and after, by these two points, draw the line FD; so shall D represent the place of the Ship, and as AF is the difference of latitude, so FD is the difference of Meridians, which measured in your Scale of leagues is 56 leagues.



Now to reduce this 56 leagues into degrees of longitude, you must consider from what latitude you have sailed, and to what latitude you are come, viz. from latitude 56 d. 5 m. to 4 deg. 9 min. less, which is 51 deg. 56 min. and take the middle latitude or somewhat more between the two places, which in this example falls out to be 51 d. 1 m. Then by the Table in the former Chapter, find out how many leagues and miles in the said middle latitude make one degree

degree of longitude, and you shall find in that Table, that in the latitude of 54 d. there is but 11 leagues, and 2 miles, and 27 parts in one degree of longitude. Therefore open your Compasses upon your Scale of leagues to this 11 leagues, 2 miles, 27 parts, and keeping your Compasses at that distance, set one foot of them at 56 leagues in your Scale of leagues, or in the line D F in the Figure (or upon the like line in your Chart at any time) either at F or D, and measure how many times you find that distance either to the end of your Scale coming backward, or in the line D F, for so many degrees is the difference of longitude; and if any odd part remain, you may proportion it by your eye, judging it to be a quarter, a third, an half, or any part more or less of a degree, which you may either reckon by parts, or 15, 20, 30, &c. minutes.

Thus this line D F being 56 leagues, opening your Compasses to 11 leagues 2 miles 27 parts, you will find this distance in it, 4 times and 3 quarters; so that the difference of longitude is 4 deg. 45 min.

Or you may reduce it into miles and work by the rule of proportion, so you shall find

As 11 leagues 2 miles 27 parts, that is 35 miles 27 parts,	35,27
To one degree of longitude in the latitude of 54 d.	01,00
So is 56 leagues, or 168 miles,	168,00
To 4 degrees 76 parts,	04,76

But if your Scale be large, the other way with your Compasses will give you the degrees and parts of longitude as exactly as you need, for most uses.

Also if the latitude fall not out in equal parts, you may find out for your odd minutes by proportion; for which purpose I have set the differences between each degree in the Table.

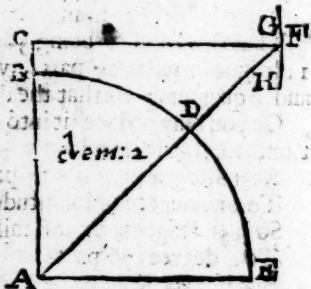
So that as one hundred parts, or 60 minutes, being one degree to the difference in the Table between the two next degrees;

So the odd hundred parts or minutes of latitude, to the parts and minutes proportional to be allowed.

CHAP. XVI.

Sailing from the South latitude of 60 degrees 51 min. and from longitude 25 degrees 24 min. 99 leagues, upon a South-west course: the latitude and longitude of the second place is demanded.

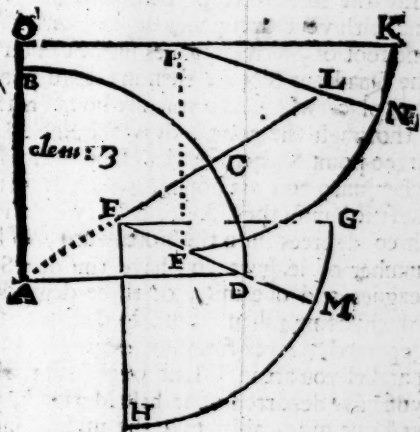
IN the second Demonstration, draw the Quadrant *ABCDE*, as is formerly taught; then in regard you sail South-west, take four points of the Compass from your Scale, and place them from *B* unto *D*, then by the point *D* draw the line *ADF*, then place your ninety nine leagues upon the line *ADF*, from *A* unto *F*, so shall *F* be the place of your ship. Then from *F* draw the line *FC* parallel unto *AE*, cutting the line *ABC* in *C*, so shall the distance *CA* be the leagues you have run South, which is 70 leagues, or 3 deg. 30 min. which being added to the latitude from whence you departed, makes 64 deg. and 21 min. for the latitude of the second place: then take the distance *CF*, and apply it unto the line of equal parts, and you shall find it likewise 70 leagues: Then finding the middle latitude 62 degrees 36 minutes in the Table, Chap. 14. you shall find that 9 leagues, and 0 miles, and 61 parts, do alter a degree of longitude in that latitude. Then opening the feet of your Compasses to 9 leagues, and 0 miles, 61 parts, in the Scale of equal leagues, and keeping the Compasses at that distance, see how many times that distance is in the line *CF*, which is seven times and somewhat above an half, the true difference of longitude being 7 deg. 35 min. which being subtracted from the longitude from whence you departed, leaves 17 degrees and 48 minutes for the longitude of the second place.



C H A P. XVII.

A Ship sailing from the North Parallel of fifty degrees, having an hundred leagues to sail South-west and by West, by the way is enforced by contrary winds to sail upon several points of the Compass, first sailing thirty leagues upon a direct course, then West North-west twenty leagues, then South sixty leagues; the question is to find the latitude of the second place, how far it is to the place whereunto you are bound, the distance of the Rumb that is betwixt them, the distance that you are from your first Meridian, and thereby the difference of longitude?

IN the third demonstration draw the line AD , and from the point A , raise the perpendicular AB , then open your Compass unto the Radius of your Scale, and place one foot thereof in the center A , and with the other draw the Quadrant BCD , then take three points of the Compass, and place them upon the Quadrant from D unto C , then from the center A , by the point C , draw the line ACL 100 leagues in length, which is the true course you are to sail; Then in regard you sailed thirty leagues direct, take thirty leagues from your Scale of equal parts, and place them upon the line AEC , it extends from A unto E : then in regard you turned your Course West North-west, from the Center E , draw the Line EG parallel to AD : and again, from the Center E draw the line EH perpendicular to EG , and parallel to AB , then with



with the distance of the Radius, set one foot of your Compasses in the center E, and with the other draw the Quadrant G M H, and in regard you sailed West Northwest, which is two points from the West Northward, take from your Scale two points of the Compass, and place them upon the Quadrant G M H, from G unto M, then from the center E unto the point M draw the line E F M, then take 20 leagues with your Compasses from the scale of equal parts, and place them upon the line E F M, from E unto F, then is your Ship in the point F. Lastly, in regard you run South 60 leagues from F, draw a line parallel unto the Meridian A B, which is the line F I, then take from your Scale of equal parts 60 leagues, and place them from F unto I, then is your Ship in the point I: then last of all is to be found how far it is to the place whereunto you are bound, the distance of the Rumb that is betwixt you, the degrees and minutes you have raised the Pole, the distance of departure from the first Meridian, and thereby the difference of longitude: and that you may so do, first draw the line O I K perpendicular unto the line I F in the point I, and with your Compasses opened unto the distance of the Radius, set one foot of your Compasses in the Center I, and with the other draw the Quadrant K N F, then in regard your Ship is in the point I, and the place whereunto you are bound is the point L, therefore from I through the point L draw the line I L N, cutting the arch K N F in the point N, therefore let I L be the leagues you have unto the place whereunto you are bound, which is forty one leagues and a half, and the Rumb the distance K N, which is West and by North, and three degrees unto the Northward, so likewise is the line A O the number of leagues you have run due South, which is sixty eight leagues and one mile, or three degrees and twenty five minutes, which being taken from fifty degrees, the parallel from which you departed, leaves forty six degrees and thirty five minutes for the parallel you are in. Last of all shall the line I O be the leagues that you have departed your first Meridian, which are forty two leagues and one mile; then take the middle latitude, which is forty eight degrees seventeen minutes; and in the Table chap. 14. you shall find that thirteen leagues, 0 mile, 02 parts, do answer unto a degree of longitude in that parallel; then setting one foot of your Compasses in

point L draw the line LM parallel unto GHF, then open your Compasses unto the distance of a hundred leagues, which are the leagues the second Ship did run; and set the foot of your Compasses in the center A, and with the other make a mark in the line LM, which will be at M, then draw the line MA, which is the course of the second Ship, and the line FA is the course of the first Ship; then from F let a perpendicular fall, being perpendicular to the line GF, which is the line FK, then opening your compasses unto the Radius of your Scale, set one foot in the center F, and with the other draw the Quadrant HIK; likewise from M, the place of the second, draw a line by the point M, the place of the second, cutting the Quadrant KHI in I, so let IK be the course that is betwixt them, that is, if you will sail from the first ship unto the second, you must sail North and by East, and one and forty minutes to the Eastward; likewise let FM be the distance that is betwixt them; which in this Demonstration is forty Leagues, two Miles, so shall BC be the course of the first Ship from the West Northward, which here is found to be thirty degrees and one minute from the West Northward, or North-west by west, and three degrees forty four minutes to the westward. Lastly, the arch ED is in the distance of the course that the second ship made from the North Westward, which is found by this Demonstration to be Northwest and by North, and three degrees five minutes to the Westward.

C H A P. XIX.

Two Ships departing from one Parallel and Port in the Parallel of 47 deg. 56 min. the first in sailing 80 leagues betwixt the North and West, hath raised the Pole two degrees: I demand by what course the second Ship must run, and how much she shall alter in her first Meridian or Longitude, to bring her self 40 leagues and two miles North and by East, and 41 minutes to the Eastward of the first Ship.

IN the fourth Demonstration draw the Quadrant ABCDE, then multiply your two degrees you have altered your latitude by twenty, and make it forty Leagues; which forty Leagues set

of longitude in that Parallel: Then set one foot of your Compasses in 12 leagues 2 miles and 62 parts, and open the other to the beginning of the line, and with that distance measure the line LM, being 60 leagues, and you shall find that it is contained therein four times and two thirds, so the longitude is 4 degrees 40 minutes.

C H A P. XXI.

Of the Ebbing and Flowing of the Sea, and of the Tides, and how to find them in all places.

A general Table for the Tides in all places.

<i>The Moons age.</i>			<i>The Moons age.</i>		
<i>Hours and minutes to be added.</i>			<i>Hours and Minutes to be added.</i>		
<i>Days.</i>	<i>Degrees</i>	<i>Minutes</i>	<i>Days.</i>	<i>Degrees</i>	<i>Minutes</i>
1	0	48	16	0	48
2	1	36	17	1	36
3	2	24	18	2	24
4	3	12	19	3	12
5	4	0	20	4	0
6	3	48	21	4	48
7	5	36	22	5	36
8	6	24	23	6	24
9	7	12	24	7	12
10	8	0	25	8	0
11	8	48	26	8	48
12	9	36	27	9	36
13	10	24	28	10	24
14	11	12	29	11	12
15	0	0	30	0	0

The use of the Table of the Tides.

First it is to be understood, that by the swift motion of the first Mover, the Moon and all the rest of the Stars and Planets are turned about the World in four and twenty hours, upon which swift motion of the Moon, the daily motions of the Sea do depend; which motion of the Sea falleth not out always at one hour, the reason thereof is, because of the swift motion of the Moon, in regard she goeth almost thirteen degrees in four and twenty hours, and the Sun moveth scarce one degree, which gives every day twelve degrees, that the Moon cometh slower to any point in the Heaven than the Sun; which twelve degrees, makes forty eight minutes of time for the difference of every full Sea, according to the middle motion of the Moon, which difference is here set down in this Table for every day of the Moons Age. Therefore if you would know the full Sea at any place in the World, first you must know at what hour it is full Sea at the new or full Moon; which hours and minutes keep in mind, then seek the age of the Moon, as is before taught, and with the number of her age enter this Table under the Title of the Moons age; and having found her age in the Table, against it you shall find the hours and minutes which are to be added unto the time that the Moon maketh full Sea in any place, and the whole number of hours and minutes is the time that the Moon maketh full Sea in that place upon the day desired: as for example, I desire to know the full Sea at *London-Bridge* upon the thirteenth of *July 1624.* the age of the Moon being found as before, is eight days, then in the Table I find eight days, and against it 6 hours, and 24 minutes, which being added unto three hours, the full Sea upon the change day, gives 9 a clock 24 minutes, for the time at the full Sea upon the 13 day of *July, 1624.*

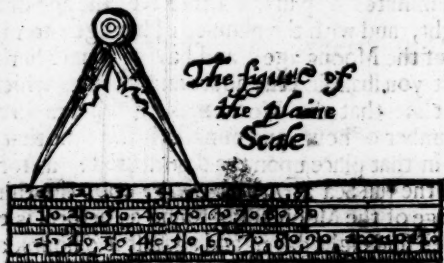
THE SEAMANS GLASS.

The Second Book.

Wherein is declared the Definition of the Sphere, a Description of the six great Circles, and also of the four lesser Circles. Last of all, certain Questions Astronomical, performed by the said Scale.

CHAP. I.

Of a Sphere, and the Circles thereof.



Sphere, according to the Description of *Theodosius*, is a certain solid Superficies, in whose middle is a Point, from which all lines drawn unto the Circumference are equal; which Point is called the Center of the Sphere; by which Center a right Line being drawn, and extending himself on either side unto that part of the Circumference whereupon the Sphere is turned, is called *Axis Sphæra*, or the Axle-tree of the World.

A Sphere accidentally is divided into two parts, that is to say, in *Spharam rectam & Spharam obliquam.*

Sphara recta, or a right Sphere, is only unto those that dwell under the *Equinoctial*, *Quibus neuter Polorum magis altero elevatur*: that is, to whom neither of the Poles of the World are seen, but lie hid in the *Horizon*.

Sphara obliqua, or an oblique Sphere, is unto those that inhabit on either side of the *Equinoctial*; unto whom one of the Poles is ever seen, and the other hid under the *Horizon*.

The Circles whereupon the Sphere is composed, are divided into two sorts; that is to say, in *Circulos majores & minores.*

Circuli majores, or the greater Circles, are those that divide the Sphere into two equal parts, and they are in number six, viz. the *Equinoctial*, the middle of the *Zodiac* or the *Ecliptick* line, the two *Colures*, the *Meridian*, and the *Horizon*.

Minores vero Circuli, or the lesser Circles, are such as divide the Sphere into two parts, unequally, and they are four in number, as the *Tropick of Cancer*, the *Tropick of Capricorn*, the Circle *Arctic*, and the Circle *Antarctic*.

CHAP. II.

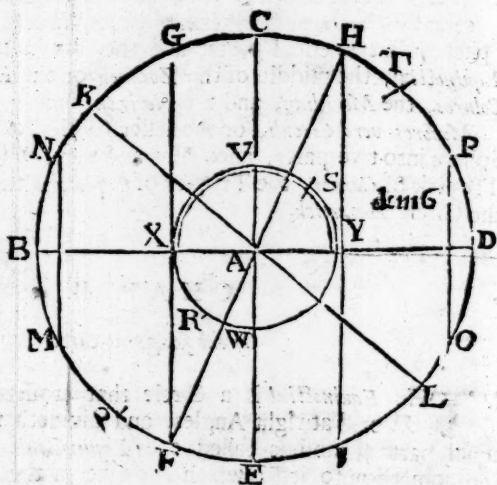
Of the six great Circles.

I. **T**HE *Equinoctial* is a Circle that crosseth the Poles of the World at right Angles, and divideth the Sphere into two equal parts, and is called the *Equinoctial*, because when the Sun cometh unto it, (which is twice in the year, viz. In *principio Arietis & Libra*, that is, in *March* and *September*) the Days and Nights are equal throughout the whole World, whereupon it is called *Equator diei & noctis*, the equal proportioner of the Day and Night artificial; and in the figure is described by the line CAE.

II. The *Meridian* is a great Circle passing thorough the Poles of the World, and the Poles of the *Horizon*, or *Zenith* point over our heads, and is so called, because that in any time of the year, or in any

any place of the World, when the Sun (by the motion of the Heavens) cometh unto that Circle, it is noon, or 12 of the Clock. And it is to be understood, that all Towns and places that lie East and West one of another, have every one a several Meridian: but all places that lie North and South one of another, have one and the same Meridian. This Circle is declared in the figure following, by the Circle BCDE.

III. The *Horizon* is a Circle dividing the superiour Hemisphere from the inferiour, whereupon it is called *Horizon*, that is to say, the bound of sight, or the farthest distance that the eye can see, and therefore it is also called *Circulus hemisphaerii*. The *Horizons* are divided into two sorts, viz. *Rectus* & *Obliquus*, a Right and an Oblique, or a declining *Horizon*: whereof those have a Right *Horizon* which have the *Equinoctial* for their *Zenith*, and the Poles of the World in their *Horizon*: because the *Horizons* (hiding both the Poles of the World) is a Circle supposed to



be drawn by the Poles of the World) is a Circle supposed to be drawn by the Poles of the World, dividing the *Equinoctial* at right angles, as in the Figure foregoing you may plainly see. First imagining the Circle XVYW to be the Earth, and those that inhabit at the point V have the line BD for their *Horizon*, cutting the *Equinoctial* CAE, at right Angles in A, and therefore is called *Horizon rectus* & *Sphaera recta*, a right *Horizon*, and a right Sphere

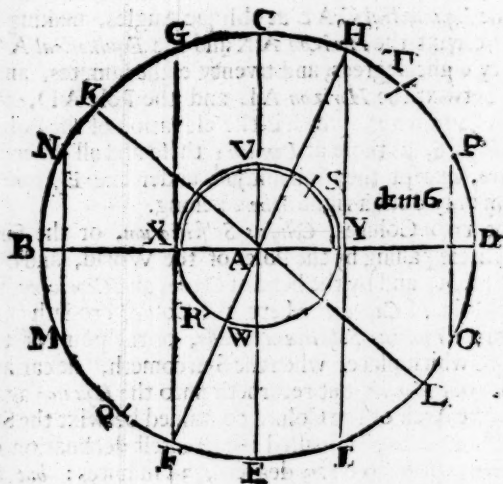
Sphere. Those have an oblique *Sphere*, or an oblique *Horizon*, to whom one of the Poles are visual, or elevated above the *Horizon*, and have the other hid under the *Horizon*, and in regard such a *Horizon* doth cross the *Equinoctial*, or oblique Angles, it is called *Horizon obliquus*, or a declining *Horizon*: As for example, Those that inhabit at the point S, have T for their *Zenith*, and K A L for their *Horizon*, dividing the *Equinoctial* C A E at oblique Angles, making the Angle contained betwixt the *Horizon* A K and the *Equinoctial* A C, an angle of thirty eight degrees, and twenty eight minutes, and the angle contained betwixt the *Horizon* A L and the Pole A D, an angle of 51 degrees 32 minutes, which is the elevation of the Pole for those that inhabit at S, as those at *London*; these and all other have an oblique *Sphere*, except they inhabit just under the *Equinoctial* Circle, unto whom only doth a right *Sphere* belong.

IV. The two Colures, *Colurus Solstitiorum*, or the Summer Colure, is a Circle passing by the Poles of the World, and by the Poles of the Ecliptick, and by the head of *Cancer* and *Capricorn*, whereupon the first scruple of *Cancer*, where the Colure crosseth the Ecliptick Line, is called *Punctus Solstitia æstivalis*, or the point of the Summer Solstice: to which place, when the Sun cometh, he can approach no nearer unto our *Zenith*, but returneth unto the *Equator* again. *Arcus vero Coluri*, the Arch of the Colure, contained betwixt the Summer Solstice and the *Equator*, is called the greatest declination of the Sun, which *Ptolomy* found to be 23 degrees, 31 minutes: but by the observation of *Copernicus* it was found to vary, for he found the declination sometimes to be 23 degrees 52 minutes, and in the process of time, to be but 23 degrees 28 minutes. And in these our days (by the observation of *Tycho de Brache*, and the late famous *Mathematician* Mr. *Edward Wright*) it is found distant from the *Equinoctial* 23 degrees, 31 minutes, 30 seconds.

V. The other Colure passeth by the Poles of the World, and by the first point of *Aries* and *Libra*, whereupon it is called *Colurus distinguens Equinoctia*. These two Colures do cross each other at right angles in the Poles of the World, whereupon these Verses were made.

*Hæc duo Solstitia faciunt Cancer, Capricornus,
Sed noctes æquant Aries & Libra diebus.*

VI. The Zodiac is another of the greater Circles, dividing the *Equinoctial* into two equal parts by the head of *Aries* and *Libra*, the one half of it doth decline unto the North, and the other unto the South, the greatest of which declinations is 23 degrees, 31 m. and 30 f.



Note also this Circle is divided into twelve equal parts, which parts are attributed unto the twelve Signs, *Aries*, *Taurus*, *Gemini*, *Cancer*, *Leo*, *Virgo*, *Libra*, *Scorpio*, *Sagittarius*, *Capricornus*, *Aquarius*, and *Pisces*. And every one of these Signs are divided into 30 equal parts, which are called degrees; so the whole Zodiac containeth three hundred and sixty degrees. Likewise every degree is divided into sixty equal parts, which parts are called minutes, and are in number 21600 minutes; and as 21600 minutes is the whole circumference of the Heavens, so is 21600 miles the whole circuit of the Earth.

C H A P. III.

Of the four lesser Circles.

THe Sun having ascended unto his highest Solstitial point doth describe a Circle, which is the nearest that he can approach unto the North Pole, whereupon it is called *Circulus Solstitii æstivalis*, the Circle of the Summer Solstice, or the Tropick of *Cancer*, and is noted in the figure before by the line H Y I.

The Sun also approaching unto the first scruple of *Capricornus*, or the Winter Solstice, describeth another Circle, which is the utmost bounds that the Sun can depart from the Equinoctial Line towards the Antartick Pole, whereupon it is called *Circulus Solstitii hyemalis*, *five Tropicus hyemalis, vel Capricorni*, the Circle of the Winter Solstice, the Winter Tropick, or the Tropick of *Capricorn*, and is described in the figure by the line G X F.

So much as the Ecliptick declineth from the Equinoctial, so much doth the Pole of the Ecliptick decline from the Poles of the World, whereupon the Pole of the Ecliptick, which is by the North Pole of the World, describeth a certain Circle as it passeth about the Pole of the World, being just so far from the Pole, as the Tropick of *Cancer* is from the Equator, and it is the third of the lesser Circles, and is called *Circulus Arcticus*, or the Circle of the North Pole, and is described in the *Diagram*, in the second Chapter by the line P O.

The fourth and last of the lesser Circles, is described in like manner by the other Pole of the Ecliptick, about the South Pole of the World, and therefore called *Circulus Antarcticus*, the Antartick Circle, or the Circle of the Antartick or South Pole, and is demonstrated in the former figure, by the line N M.

C H A P. IV.

Definitions of some particular terms fit to be known by such as intend to practise the Art of Navigation or Astronomy.

THe Zenith is an imaginary point in the Heavens over our heads, making right angles with the Horizon, as the Equinoctial maketh with the Pole.

The Nadir is a prick in the Heavens under our feet, making right angles with the Horizon under the Earth, as the Zenith doth above, and therefore is opposite unto the Zenith.

The declination of the Sun is the Arch of a Circle contained betwixt the place of the Sun in the Ecliptick and the Equinoctial, making right angles with the Equinoctial. But the declination of a Star is the Arch of a Circle let fall from the Center of a Star, perpendicularly unto the Equinoctial.

The Latitude is the arch of a circle contained betwixt the Center of any Star and the Ecliptick line, making right angles with the Ecliptick, and counted either Northward or Southward, according to the situation of the Star, whether it be nearer unto the North or South Pole of the Ecliptick.

The Latitude of a Town or Country is the height of the Pole above the Horizon, or the distance betwixt the Zenith and the Equinoctial.

The Longitude of a Star, is that part of the Ecliptick which is contained betwixt the Stars place in the Ecliptick, and the beginning of *Aries*, counting them from *Aries*, according to the succession or order of the Signs.

The Longitude of a Town or Countrey are the number of degrees which are contained in the Equinoctial, betwixt the Meridian that passeth over the Isles of *Azores*, (from whence the beginning of longitude is accounted) Eastwards, and the Meridian that passeth over the Town or Country desired.

The Altitude of the Sun or Star is the arch of a Circle contained betwixt the Center of the Sun, or any Star, and the Horizon.

The

The Amplitude is that part of the Horizon which is betwixt the true Eaſt or Weſt points, and the point of the Compaſs that the Sun or any Star doth riſe or ſet upon.

Azimuths are Circles which meet together in the Zenith, and croſs the Horizon at right angles, and ſerve to find out the point of the Compaſs which the Sun is upon at any hour of the day; or the Azimuth of the Sun or Star, is a part of the Horizon contained betwixt the true Eaſt and Weſt point, and that Azimuth which paſſeth by the Center of the ſame Star to the Horizon.

The right aſcenſion of a Star is that part of the Equinoctial that riſeth or ſetteth with the Star in a right Sphere: or in an oblique Sphere, it is that proportion of the Equinoctial, contained betwixt the beginning of *Aries*, and that place of the Equinoctial which paſſeth by the Meridian with the Center of the Star.

The oblique aſcenſion is a part of the Equinoctial, contained betwixt the beginning of *Aries*, and that part of the Equinoctial that riſeth with the Center of a Star in an oblique Sphere.

The difference aſcenſional, is the difference betwixt the right and oblique aſcenſion: or it is the number of degrees contained betwixt that place of the Equinoctial that riſeth with the Center of a Star, and that place of the Equinoctial that cometh unto the Meridian with the Center of the ſame Star.

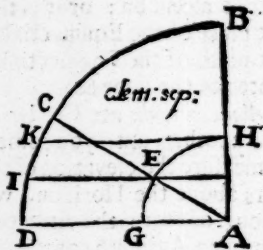
Almicanterahs are Circles drawn parallel unto the Horizon, one over another, until you come unto the Zenith: theſe are Circles that do meaſure the elevation of the Pole, or height of the Sun, Moon, or Stars above the Horizon, which is called the Almicanter of the Sun, Moon, or Star: the Arch of the Sun or Stars Almicanter, is a portion of an Azimuth contained betwixt that Almicanter which paſſeth thorow the Center of the Star and the Horizon.

QUESTIONS ASTRONOMICAL;
performed by the plain Scale.

C H A P. V.

*The true place of the Sun being given, to find his declination.
The Sun being in the head of Taurus, his declination is desired.*

BY the seventh Demonstration draw the line A D, then upon the Center A raise the perpendicular A B, then opening your Compasles to the Radius of your Scale, place one foot in the Center A, and with the other draw the Quadrant B C D, then opening your Compasles unto the greatest declination of the Sun, place it upon the Quadrant from D unto K, then from the point K draw the line K H parallel to D A, cutting the line A B in H, then with the distance A H draw the small Quadrant G E H, and in regard the Sun is in the head of Taurus, which is 30 degrees from the beginning of Aries, let A D be the Equator, and D the beginning of Aries, D C 30 degrees, or longitude of the Sun, then from the point C draw the line C A, cutting the Quadrant G E H in E, then from E draw the line E I parallel to A D, cutting the Quadrant B C D in I, so shall the arch I D be the declination of the Sun desired, which in this Demonstration is found to be eleven degrees, and thirty one minutes.



C H A P. VI.

The declination of the Sun, and quarter of the Ecliptick that he possesseth, being given, it is desired to find his true place.

The declination is 10. deg. 31 min. the first quarter that he possesseth, is betwixt the head of Aries and Cancer.

First by the seventh Demonstration, draw the Quadrant ABCD, as is taught in the former Chapter, then set the greatest declination of the Sun upon the Chord from D unto K, which is 23 deg. and 31 min. then from K draw the line KH parallel unto the Equator DA, cutting the line BA in the point H. So shall HA be the sign of the Suns greatest declination; then with the distance AH draw the Quadrant GEH, then from D upon the Quadrant DBC set the Declination of the Sun, which is 11 degrees, 31 minutes from D unto I, then draw the line IE parallel unto AD, cutting the Quadrant GEH in E. Then from the center A by the point E, draw the line AEC, cutting the Quadrant BCD in C. So shall the arch CD be the distance of the Sun from the head of Aries, which is here found to be just 30 degrees, which is in the beginning of Taurus.

C H A P. VII.

By the elevation of the Pole, and declination of the Sun, to find the amplitude of the Sun, or his distance of rising or setting from the true East or West point.

The elevation of the Pole is 51 deg. 32 min. the declination of the Sun is 14 deg. 52 min. North.

BY the eighth Demonstration, first draw the line BD, then upon the Center A draw the Circle BCDE, then from A raise the perpendicular CAE, then is your Circle divided into four equal parts: then suppose the elevation of the Pole to be

C H A P. VIII.

By the Amplitude of the Sun, to find the variation of the Compass.

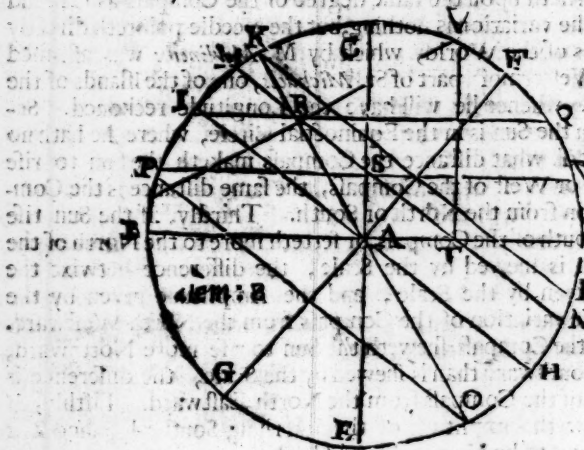
HAVING found the amplitude of the Sun by the last Chapter, first observe with a Compass, or rather with a Semicircle, upon what degree and minute the Sun riseth or setteth, beginning to reckon from the East or West, and ending at the North or South at 90 degrees; and when you have diligently observed the Magnetical rising or setting by the Semicircle, or by some other like fixing Instrument; and also the true amplitude found, as is declared in the last Chapter, the difference of these two amplitudes, is the variation of the Compass: But when the Sun riseth upon the same degree of the Compass as is found by the Scale, the variation is nothing, but the Needle pointeth directly unto the Poles of the World, which by *M. Adelineux* was affirmed to be at the Westermost part of *St. Michaels*, one of the Islands of the *Azores*, from whence he will have the Longitude reckoned. Secondly, when the Sun is in the Equinoctial Circle, where he hath no amplitude, look what distance the Compass maketh the Sun to rise from the East or West of the Compass, the same distance is the Compasses variation from the North or South. Thirdly, If the Sun rise more to the South of the Compass, or setteth more to the North of the Compass than is shewed by the Scale, the difference betwixt the Amplitude given by the Scale, and the Amplitude given by the Needle, is the variation of the Compass from the North Westward. Fourthly, If the Compass sheweth the Sun to rise more Northward, or set more Southward than is shewed by the Scale, the difference is the variation of the Compass from the North Eastward. Fifthly, If the Scale shew the amplitude of the Sun rising Southerly, and the Compass shew it to be Northerly, add both the amplitudes together, and they shew you the variation Westerly.

CHAP. IX.

The place of the Sun being given, to find his declination, by a whole Circle.

The Suns place is the tenth degree of Taurus.

According unto the eighth Demonstration, first draw the Circle BEDE, then draw the Horizon BAD, and then the Equinoctial IAH, as is before taught: and then the Tropick of Cancer KL twenty three degrees and an half from the Equinoctial: then draw the Tropick of Capricorn PO, of like distance from the Equinoctial,



and after from K to O draw the Ecliptick line KAO. And when you have thus laid down the Sphere, suppose the Sun to be in the tenth degree of Taurus, at which time his declination is desired. And in regard the Sun is more near unto the Tropical point Cancer than unto Capricorn, first find how many degrees he is from the Tropick of Can-

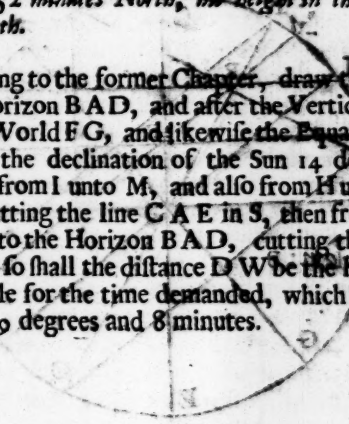
car, and you shall find him to be 50 degrees; therefore take with your Compasses 50 degrees from the Chord, and apply it from the Tropical point *Cancer* at *K* unto *V* upon one side, and unto *P* on the other side; then draw the line *VP*, cutting the Ecliptick *KO*, in the point *R*, then from *R* draw the line *M R N* parallel unto the Equinoctial *I A H*, and cutting the Quadrant *BC* in the point *M*. So shall the arch *MI* be the declination of the Sun desired, which being applied unto your Scale, gives 14 deg. and 52 min.

CHAP. X.

The elevation of the Pole, and declination of the Sun given, to find his height in the vertical Circle.

The Pole is elevated 51 degrees, 32 minutes, the declination of the Sun is 14 degrees 52 minutes North, his height in the Vertical Circle is found as followeth.

First, according to the former Chapter, draw the Circle *BCDE*, then the Horizon *BAD*, and after the Vertical line *CAE*, then the Axis of the World *FG*, and likewise the Equator *I A H*; this being done, place the declination of the Sun 14 degrees 52 minutes, upon the Circle from *I* unto *M*, and also from *H* unto *N*, then draw the line *M N*, cutting the line *CAE* in *S*, then from *S* draw the line *SW* parallel unto the Horizon *BAD*, cutting the Meridian Circle *BCDE* in *W*: so shall the distance *DW* be the height of the Sun in the vertical Circle for the time demanded, which by this proposition is found to be 19 degrees and 8 minutes.



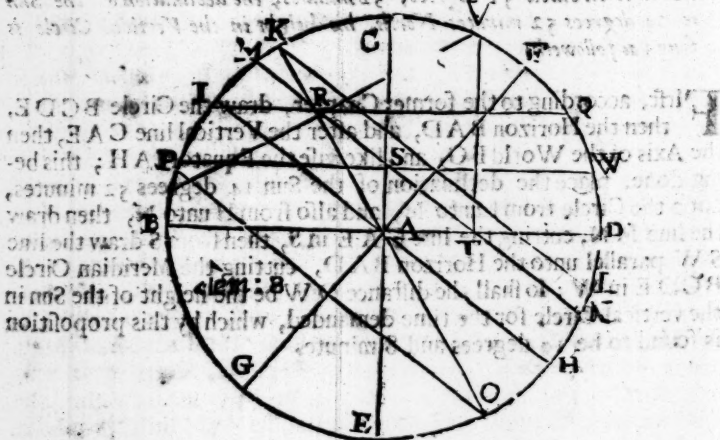
then draw the line *CAE*, then the Axis of the World *FG*, and likewise the Equator *I A H*; this being done, place the declination of the Sun 14 degrees 52 minutes, upon the Circle from *I* unto *M*, and also from *H* unto *N*, then draw the line *M N*, cutting the line *CAE* in *S*, then from *S* draw the line *SW* parallel unto the Horizon *BAD*, cutting the Meridian Circle *BCDE* in *W*: so shall the distance *DW* be the height of the Sun in the vertical Circle for the time demanded, which by this proposition is found to be 19 degrees and 8 minutes.

CHAP. XLV

The elevation of the Pole, and the amplitude of the Sun being given, to find the declination.

The elevation of the Pole is 51 degrees 32 minutes, the Suns amplitude is 24 degrees 21 minutes, the declination is found as followeth.

First, As in the eighth demonstration, upon the Center A, draw the Circle B C D E, then draw the Line B A D, representing the Horizon: dividing the Circle into two equal parts



then draw the Line C A E, perpendicular to B A D, representing the East and West points of the Compass, then placing the elevation of the Pole 51 degrees and 32 minutes, from D unto F, from F by the Center A draw the line F A G, which let be the Pole or Axle-tree of the World; then from B unto I, and from D unto H, set

set the Complement of the Poles elevation: which shall represent the Equinoctial, in regard it maketh right angles with the Pole of the world in the center A. Then from C unto V place the amplitude of the Sun, which is 24 degrees and 21 minutes: then from V let fall the perpendicular VT, cutting the Horizon BAD in the point T, then from the point T draw the line MTN parallel unto the Equinoctial IAH, and cutting the Circle BCDE in the points M and N, so shall the distance IM or HN be the declination of the Sun, which was desired: which being applied unto your Scale, gives you fourteen degrees and fifty two minutes.

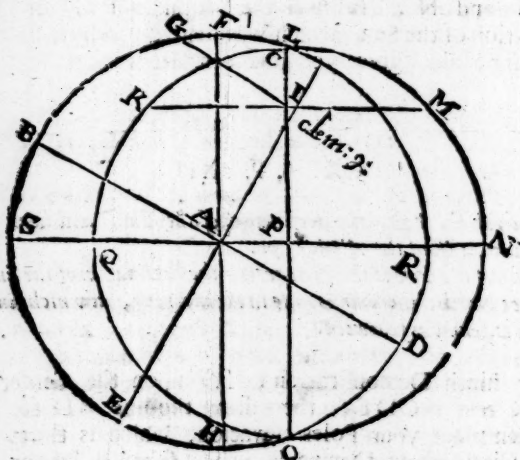
CHAP. XII.

The elevation of the Pole, the declination of the Sun, and hour of the day being given, to find the Almicanter.

The elevation of the Pole is thirty degrees, the declination of the Sun is twenty degrees North, the hour is nine in the morning, at which time the Almicanter is found as followeth.

BY the ninth Demonstration, first upon the Center A draw the Circle BCDE, then draw the line BD for the Horizon, then place your Poles elevation, which is thirty degrees, upon the Circle from D unto R, then from R by the center A draw the line RAS, representing the Axis of the World, then from B unto F place the Complement of the Poles elevation, which is 60 degrees, and from the point F, by the Center A, draw the line FAH, representing the Equinoctial line, and then set the declination of the Sun from F unto L, and from L draw the line LPO parallel unto the Equator FAH, cutting the Axis of the World in the point P, then set one foot of your Compasses in the point P, and extend the other either unto L or unto O, and with the same distance of your Compasses, upon the center P draw the Circle LNOQ, which is called the hour Circle: so shall L be the point of twelve a clock at noon, N the place of six a Clock afternoon, O the place of twelve a clock or midnight, and Q the place of six a clock

In the morning: Every one of the four quarters must be divided into six equal parts or hours, making the whole Circle to contain twenty four parts, representing the 24 hours of the day and night; then in regard the hour of the day was nine of the clock, which is three hours before noon, take three of those twenty four hours, and place them



upon the Circle LNOQ from the Meridian point L unto K, the nine a clock point in the morning, and unto M the point of three of the clock afternoon, then draw the line MK, cutting the parallel of the Sun LO in the point I, then from I draw the line IG parallel unto the Horizon BAD, which shall cut the Meridian Circle BCDE in the point G, so shall the distance of G and B, be the Almicanter of the Sun, which was desired; which in this demonstration is found to be forty eight degrees and eighteen minutes.

C H A P. XIII.

The elevation of the Pole, the Almicanter, and declination of the Sun being given, to find the hour of the day.

The elevation of the Pole is thirty degrees, the declination of the Sun is twenty degrees, the Almicanter of the Sun is forty eight degrees, and eighteen minutes, the hour of the day is found as followeth.

First, as in the ninth demonstration, upon the Center A draw the Circle BCDE, then draw the Diameter BD, representing the Horizon, then from D unto R set 30 degrees, the elevation of the Pole, then from R unto the point A draw the line RAS, representing the Pole of the World, then draw the line FAH, crossing the Pole in A, at right Angles cutting the Meridian Circle in F, then from F set twenty degrees, the declination of the Sun unto L, and then from the point L, draw the line LPO, representing the parallel of the Sun, and cutting the Pole of the World in P, then placing one foot of your Compasses in P, extend the other unto L, with which distance of your Compasses draw the hour Circle LNOQ, then from the Horizon at B, place the Suns Almicanter (which is forty eight degrees, and eighteen minutes) upon the Quadrant RGL, from B unto G, then from the point G draw the line GI parallel unto the Horizon BAD, cutting the line LO in I, then from the point I draw the line KIM parallel to the Pole of the World QAN, cutting the Circle LNO in M, then let LN be divided into six hours, whereof LM are three: whereupon I conclude, that it is three hours from noon, that is, at nine of the clock in the morning, or three in the afternoon.

C H A P. XVI.

The Latitude of the place, the Declination of the Sun, and the Altitude of the Sun being given, to find the hour of the day: By a new way, differing from that in the former Chapter.

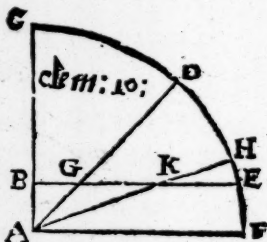
	deg.	min.		deg.	m.
The Suns declination is	48	18	} its Compl. N.	60	00
The Latitude of the place is	30	00			
The Suns Altitude is	20	00		70	00
				<hr/> Sum 130	
				difference 10 00	

The Complement of any arch less than 90 degrees, is so much as the arch wants of 90 degrees: as the Complement of 20 degrees is 70 degrees, &c.

First find the sum and difference of the Complement of the Suns declination, and the Complement of the Latitude, as above is done, where the sum is 130 degrees, and the difference 10 degrees. Then your Compasses being opened to the Radius of your line of Chords, describe the Semicircle ABC, and divide it into two Quadrants by the perpendicular BD, then out of your line of Chords take 48 deg. 18 min. the Suns Altitude, and set it from B to E, and draw EF parallel to BD: Then from your line of Chords take 130 deg. the sum, and set it from A to G, (or its Complement to 180 deg. which is 50 deg. from C to G) and draw the line GH also parallel to BD. Again, out of your line of Chords take 10 deg. (which is the difference) and set that distance from A to K, and draw KL parallel to EF or BD.

This done, take with your Compasses the distance from F to H, and setting one foot in A, with the other describe the arch MP, likewise take the distance from F to L, and setting one foot in C, with

height of your *Gnomon*, or substance yielding shadow be the line A B, which is to be divided into 12 equal parts, which *Gnomon* I have here made just 12 degrees of the equal leagues of the Scale, then from B to the top of the *Gnomon* draw the line B E parallel unto A F, then set the Almicanter which is forty five degr. from F unto D, and from the point D draw the line D A, cutting the line B E in the point G, so shall B G be the length of the right shadow desired, which here is found to be 12 parts, which is but just the length of your *Gnomon*, $\frac{2}{3}$ and $\frac{1}{3}$ of a twelfth over: Note that the right shadow is the shadow of any post, stuff, or steeple, that standeth at right angles with the Horizon, the one end thereof respecting the Zenith of the place, and the other the *Nadir*.



CHAP. XVI.

The Almicanter, or height of the Sun being given, to find the length of the contrary shadow.

The Almicanter given is 70 degrees.

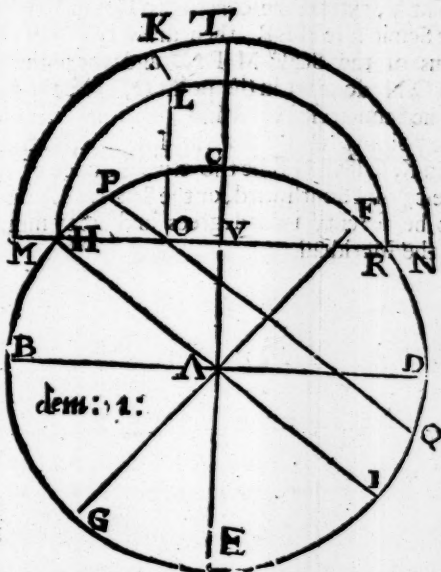
BY the verse or contrary shadow, is understood the length of any shadow that is made by a staff or *Gnomon* standing against any perpendicular Wall; in such a manner that it may lye parallel unto the Horizon, the length of the contrary shadow doth increase as the Sun riseth in height; whereas contrariwise, the right shadow doth increase in length, as the Sun doth decrease in height: the way to find the verse shadow is as followeth. First, draw your Quadrant as is taught in the last Chapter, wherein let A B be the length of the *Gnomon*; likewise from B, draw the line B E parallel unto A F, as before; then set your Almicanter from C upon the Quadrant which is given to be seventy degrees, and it will extend from C unto H, then from the point H draw the line H A, cutting the line B E in the point K, so shall K B be the length.

length of the contrary shadow, which here is found to be thirty four degrees and eight minutes, or twice so long as your *Gnomon*, and $\frac{1}{2}$ about $\frac{1}{2}$ part of a twelfth more.

CHAP. XVII.

The Latitude of the place, the Almicanter, and Declination of the Sun being given, to find the Azimuth.

The Latitude of the place is fifty one degrees, thirty minutes, the declination of the Sun twenty degrees North, the Almicanter thirty eight degrees thirty minutes, the true Azimuth of the Sun is desired.



First, as in the eleventh Demonstration upon the Center A, draw the Circle BCDE, then draw the Diameter BAD, and from D unto F, set the Elevation of the Pole, which is

one and fifty degrees, and thirty minutes, whose complement is eight and thirty degrees and thirty minutes; which must be placed from B unto H, then from H draw the line H A I, representing the Equinoctial line, and from F draw the line F A G, representing the Pole of the World, then from H unto P, and from I unto Q, set the Declination of the Sun, which is twenty degrees, and by these two points draw the line P Q, for the parallel of the Suns declination; then upon the Circle from B unto H set the Suns Almicanter, thirty eight degrees and thirty minutes; then from H draw the line H R parallel unto the Horizon cutting the Suns parallel P O Q in O, then draw the line T V A E perpendicular unto the line B A D in the Center A, and cutting the line H V R in V; then setting one foot of your Compasses in the point V, extend the other unto R, and with the same distance draw the Semicircle H L R, then draw the Concentrick Circle upon the Radius of the Scale M T N, and where the line P O Q, and the line M O N do meet in the point O, raise the perpendicular O L, cutting the Semicircle H L R in L, then lay the Scale from the Center A to the point L, and draw the line L K, cutting the Semicircle M T N in K, so shall M K be the true distance of the Sun from the East or West point Southward, or the Suns true Azimuth, which is here found to be seventy two degrees and forty minutes from the South part of the Meridian.



CHAP. II. In the eleventh Diagram the Center A, draw the Circle B C D E, then draw the Diameter B A, and from D unto F, set the Elevation of the Pole, which is

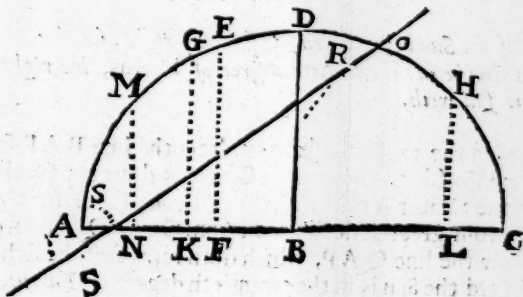
C H A P. XVIII.

The Latitude of the place, the Declination of the Sun, and the Altitude of the Sun being given, to find the Azimuth: By a new way, differing from that in the former Chapter.

	deg.	min.	S		deg.	m.
The Suns declination is	20	00	} its Compl.	}	38	30
The Latitude of the place is	51	30				
The Suns Altitude is	12	00				71
					<hr/> Sum 116	

HAVING found the sum and the difference of the Complement of the Suns altitude and Complement of the latitude as above is expressed, where you find the sum of them to be 116. deg. 30. min. and their difference 39. deg. 30. min.

These things being premised, with your Compasses being opened to 60 deg. of your line of Chords, describe the Semicircle A D C, and



upon the Center B erect the perpendicular BD, then first out of your line of Chords take 20 deg. the declination, and set that distance

distance from D to E, (if the Sun have South declination (as in this Example it hath) or from D to O, if the Sun have North declination) and draw the line EF parallel to DB.

Secondly, Take 116 deg. 30 m. the sum out of your line of Chords; and set it from C to G, and draw the line GK parallel to DB.

Thirdly, Take 39 deg. 30 min. the difference, out of your line of Chords, and set it from C to H, and draw the line HL parallel also to BD.

Fourthly, Take in your Compasses the distance from F to K, and setting one foot in A, with the other describe the arch S.

Fifthly, Take the distance from F to L, and setting one foot in C, with the other describe the arch R.

Sixthly, Lay a Ruler that it may only touch these two arches, S and R, and by it draw a line as SR, cutting the line AC in N.

Lastly, upon the point N, erect the perpendicular NM, then the distance AM measured upon your line of Chords, is the Azimuth from the South part of the Meridian, which in this example will be found to be 34 deg. MC the Azimuth from the North 146 deg. and MD the Azimuth from the East or West 56 deg.

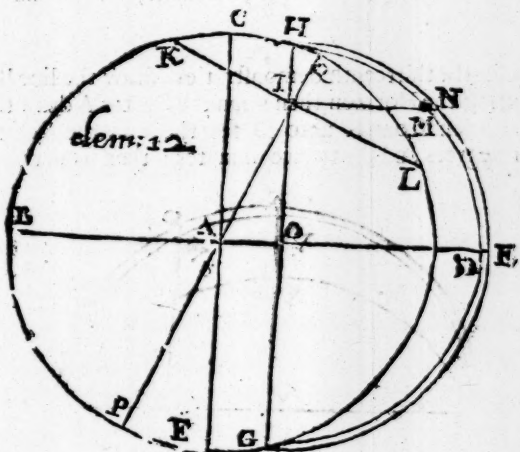
CHAP. XIX.

The place of the Sun being given, to find the right ascension.

Suppose the Sun be in the twentieth degree of Taurus, his right ascension is found as followeth.

First, as in the 12 demonstration, draw the line BAF for the Pole of the World; then upon the Center A draw the Circle BCDE, then from the Center A raise the perpendicular CAE for the Equator, then place your greatest declination from C unto Q, and from E unto P, then draw the line QAP, which doth represent the Ecliptick line, then in regard the Sun is in the twentieth degree of Taurus, which is forty degrees from the head of Cancer, which forty degr. place from Q unto L and unto K, then draw the line KL, cutting the Ecliptick in I; then from the point I draw the line HI parallel unto CAE cutting the Pole of the World in O, then set one foot of your Compasses

in O, and extend the other unto G, with which distance draw the Semicircle H D G, then opening your Compasses unto the Radius of the Scale, and upon the Center O likewise draw the Circle H N F G. then



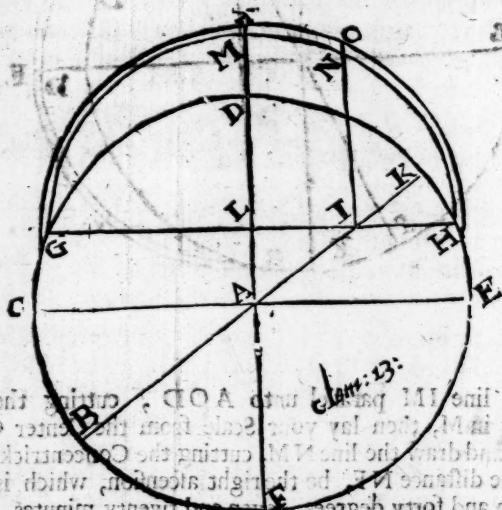
draw the line I M parallel unto A O D ; cutting the Semicircle H M D G in M, then lay your Scale from the Center O unto the point M, and draw the line N M, cutting the Concentrick Circle in N so shall the distance N F, be the right ascension, which is here found to be two and forty degrees, seven and twenty minutes.

CHAP. XX.

The elevation of the Pole, and declination of the Sun given, to find the difference of the ascensions.

The Poles elevation is 51 degrees, 32 minutes, the declination of the Sun is 21 degrees.

First, as in the thirteenth demonstration, draw the line B A K, representing the Horizon, then upon the Center A draw the Circle B C D E F, then from K unto D set the elevation of the Pole, which is 51 degrees and thirty two minutes: then from the point D,



draw the line M D, then from D unto K set the elevation of the Pole, which is 51 degrees and thirty two minutes: then from the point K, draw the line K I, then from I unto D set the declination of the Sun, which is 21 degrees: then from the point D, draw the line D F, then from F unto A set the complement of the Poles elevation, which is thirty eight degrees, and 28 minutes: then from the point C, draw the line C A E, representing the Equinoctial line; then

by the Center A, draw the line D A F, representing the Pole of the World, then from B unto C set the Complement of the Poles elevation which is thirty eight degrees, and 28 minutes: then from C by the Center A draw the line C A E, representing the Equinoctial line; then

then from C unto G, and likewise from E unto H, for the declination of the Sun, which is 21 degrees, then from G unto H draw the parallel of the Suns declination, cutting the Pole of the World in L, and the Horizon in I, then set one foot of your Compasses in the point L, and extend the other unto G, then with that distance of your Compasses draw the Semicircle G M N H, then opening your Compasses unto the Radius of your Scale, upon the same Center draw the Concentrick Circle G X O H, then from I, where the declination of the Sun doth cut the Horizon, draw the line I N parallel unto the Pole of the World A M, cutting the Circle G M H in N, then lay your Ruler from the point I unto the point N, and so draw the line N O, cutting the Concentrick Circle G X O H in O, so shall the distance of O and X be the difference of the ascensions, which is here found to be eight and twenty degrees, and four and fifty minutes.

C H A P. XXI.

The right ascension of the Sun or of a Star being given, together with the difference of their ascension, to find the oblique ascension or descension.

The Sun is in the fourth degree of Sagittarius, his right ascension is 242 degrees, or 16 hours 8 minutes, the difference of ascension is 1 hour 53 minutes or 28 degrees, 28 minutes, the oblique ascension or descension is required.

THe right ascension of any point of the Heavens being known, the difference of the ascension is either to be added thereunto, or else to be subtracted from it, according as the Star is situate in the Northern or Southern Signs: As for example, if the Sun be in any of these six signs, *Aries, Taurus, Gemini, Cancer, Leo or Virgo*, then the difference of the ascensions is to be subtracted from the right ascension, and the remainder is the oblique ascension. Suppose therefore the Sun to be in the fourth degree of *Gemini*, where the right ascension is found to be four hours, and 8 minutes, or 62 degrees, and the difference of ascension where the Pole is elevated 51 degrees, is found to be one hour 53 minutes, otherwise 28 degrees 50 minutes,

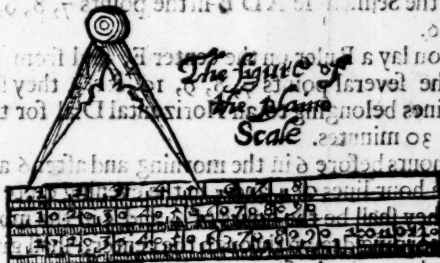
minutes, which being taken from the right ascension, leaves two hours and 16 minutes, or 33 degrees and 42 minutes, which is the oblique ascension of the Sun in the fourth degree of *Gemini*. But if the Sun be upon the South side of the Equinoctial, either in *Libra*, *Scorpio*, *Sagittarius*, *Capricornus*, *Aquarius*, or *Pisces*, then the difference of the ascension is to be added unto the right ascension, and the Products will be the oblique ascension. Suppose the fourth degree of *Sagittarius* is given, for which sign and degree the oblique ascension of the Sun is desired, his right ascension being then found to be 242 degrees, or 16 hours 8 min. the difference of the ascensions is one hour 53 min. or 28 degrees 18 minutes: which being added unto the right ascension, makes 18 hours one minute, or in degrees 270 degrees and 18 minutes, which is the oblique ascension of the Sun when he is in the fourth degree of *Sagittarius*. And if you would find the oblique descension, you must add the difference of the ascensions unto the right ascension, when the Sun is in these six Signs, *Aries*, *Taurus*, *Gemini*, *Cancer*, *Leo*, *Virgo*: and contrariwise, when the Sun is in the other six Signs, you must subtract the difference from the right ascension, and you shall have the oblique descension of the Sun or any Star, whose right ascension and difference of ascensions is known. But it is to be understood, that this manner of operation doth serve no longer than you are upon the North side of the Equinoctial. For if the South Pole be elevated, the work is contrary: for so long as the Sun is in any of the Northern Signs, the difference of the ascensions is to be added unto the right ascension, to find the oblique ascension; and contrariwise, subtracted to find the oblique descension. Likewise if the Sun or Star be in the Southern Signs, then is the difference of ascensions subtracted from the right ascension to find the oblique ascension, and added to find the oblique descension.

sup do this is to be understood, that the oblique ascension of the Sun is to be found in the fourth degree of *Gemini*, and the oblique descension of the Sun is to be found in the fourth degree of *Sagittarius*. And if you would find the oblique ascension of the Sun when he is in the fourth degree of *Sagittarius*, you must add the difference of the ascensions unto the right ascension, and you shall have the oblique ascension of the Sun when he is in the fourth degree of *Sagittarius*.

THE SEAMANS GLASS.

The Third Book.

Shewing how by the plain Scale to delineate
Hour-lines upon all kind of Upright Plains, either Direct
or Declining, in any Latitude.



How to draw Hour-lines upon an Horizontal Plane in any Latitude.

With the Radius of your line of Chords, upon E as Center, describe the Circle ABCD, and cross it with the Diameters AB and CD. This done, out of the line of Chords take the Complement of the Latitude of your place (which we here suppose to be London, whose Latitude is 51 deg. 30 m.

30. min. and its complement 38 deg. 30 min.) which set from B to G, from G to N, and from D to M; then lay a Ruler from A to G, and it will cut the line CD in H, and from A to N it will cut CD in O, and from A to M it will cut the same line in F.

This done, upon O (as a center) place one foot of your Compasses, and extend the other foot to F, and with this distance describe an arch of a circle, which (if the rest of your work be true) will fall just in the points A and B, and so constitute the arch AFB representing the Equinoctial Circle, and so we shall hereafter call it.

Having drawn the Equinoctial AFB, divide the Semicircle ADB into 12 equal parts in the points * * *, &c. Then laying a Ruler to the center E, and every one of these marks * * *, &c. it will divide the Equinoctial circle into twelve unequal parts in the points ● ● ● ● &c.

Again, Lay a Ruler to H, and every of these unequal parts ● ● ● ● &c. it will cut the Semicircle ADB in the points 7, 8, 9, 10, 11, 12, 1, 2, 3, 4, 5, and 6.

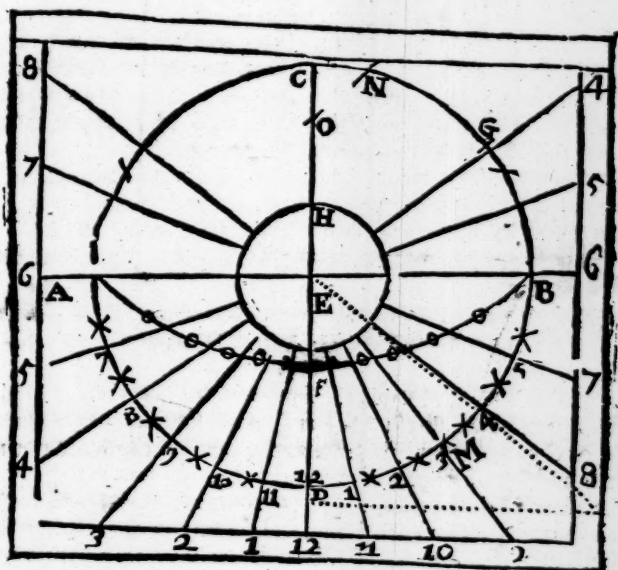
Lastly, If you lay a Ruler on the center E, and from thence draw right lines to the several points 7, 8, 9, 10, &c. they shall be 12 of the true hour-lines belonging to an Horizontal Dial for the Latitude of 51 degrees, 30 minutes.

But for the hours before 6 in the morning and after 6 at night, do thus; draw the hour-lines of 4 and 5 in the evening quite through the center E, and they shall be the hours of 4 and 5 in the morning; also 7 and 8 in the morning drawn through the center, shall give the hours of 7 and 8 at night, as in the figure.

Now for the Stile or Cock of your Dial, you must take out of your line of Chords the degrees of your Latit. viz. 51 degrees, 30 minutes, and set it from D unto S, and draw the line DS, so shall the triangle DES be the just pattern for the Cock of your Dial, which being made of Brass, or the like, and set exactly upright upon the hour-line of 12, your Dial is wholly finished.

30
51:30
38:30

An Horizontal Dial for the Latitude of 51 deg. 30 minutes.

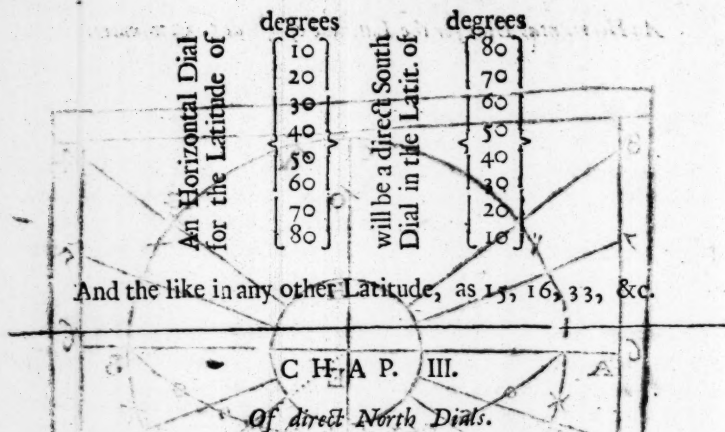


CHAP. II.

Concerning direct South Dials.

A Direct South Dial is no other than an Horizontal Dial, the making whereof is before described, the difference consisting only in the numbring of the hours; and in the placing of it, the one being to be fixed on a Post, or the like, and the other to be fixed to a Wall which exactly beholds the South, I say here is no other difference: For,

The Sea-mans Glasse.



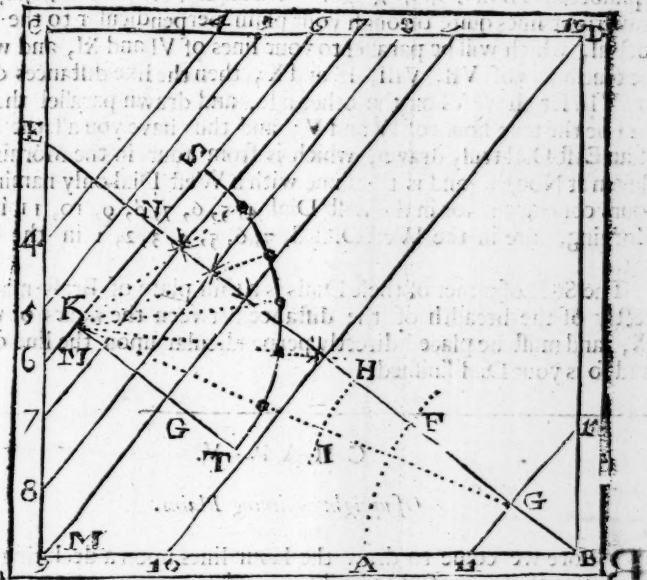
A Direct North Dial is the same with a Direct South Dial; for, if you take a South Dial and turn it upside down, causing the Stile or Cock to point upwards, as the Cock of the South doth downwards, and leaving out the hours near the Meridian, in these Northern Latitudes: as the hour of 9, 10, 11, and 12 at night, and 1, 2, and 3 in the morning, all which time the Sun is under the Horizon. I say a South Dial so disposed, and fixed against a direct North Wall, shall give you the true hour of the day.

C H A P. IV.

How to draw the hour-lines on a direct East or West Plain.

A Direct East or West Plain, is such a Plain as directly lieth open to the East or West points of the heavens; as the North and South Plains do to the North and South points. To make such a Dial, Upon the Plain C B D M (in some convenient place thereof towards the lower part) assume the point B, then with the Radius of your line of Chords upon B as a Center, describe the obscure arch A F, then from

from your Chord take the Complement of the latitude of your place, 38 degrees, 30 minutes, and set it from A to F, then from B through F draw the line BE, representing the Equinoctial Circle, which in these plains, (as also in a Polar Dial) becomes a streight line. In this line E B assume two points, one towards one end, and the other to-



wards the other end of the same line, as the points G and N, one for the hour of VI, as N; the other for the hour of XI, as G: through these two points N and G, draw two right lines quite through your Plain, perpendicular to the Equinoctial line BE, as in the figure, which two lines shall represent eleven and six of the Clock.

This

This done, upon the point G, with the Radius of your Chord deſcribe an occult arch of a circle HI, and ſet thereon 15 degrees from H to I, then from G through I draw the line GK, cutting NM in K; on K, as a center, with the Radius of your Chord deſcribe the quadrant KST, which divide into 6 equal parts in the points ●●●●●, through which points and K, draw the lines K●, K●, &c. cutting the Equinoctial EB in *** &c. Through theſe points *** &c. draw right lines quite through your plain perpendicular to the equinoctial, which will be parallel to your lines of VI and XI, and will be the true hours of VII, VIII, IX and X; then the like diſtances of VII and VIII ſet above VI on the other ſide, and drawn parallel thereto, ſhall be the true hours of IV and V; and thus have you all the hours of an Eaſt Dial truly drawn, which is from four in the Morning till eleven at Noon; and is the ſame with a Weſt Dial only naming the hours contrary: for in the Eaſt Dial 4, 5, 6, 7, 8, 9, 10, 11 in the Morning, are in the Weſt Dial 8, 7, 6, 5, 4, 3, 2, 1 in the Evening.

The Stile of either of theſe Dials is a thin plate of Braſs made directly of the breadth of the diſtance between the hours of VI and IX, and muſt be placed directly perpendicular upon the line of VI, and ſo is your Dial finiſhed.

C H A P. V.

Of upright declining Plains.

BEfore we come to draw the Hour lines upon a declining Plain, two things are firſt to be diſcovered, viz.

Firſt, *The height of the Pole above the Plain*, which is the height of the Cock or Stile.

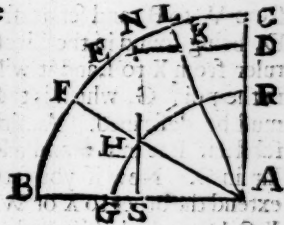
Secondly, *The deſlection* or diſtance of the ſubtile from the Meridian or line of twelve of the Clock.

1. To find the height of the Pole above a declining Plain.

With the radius of your line of Chords, upon A, as a center, describe the Quadrant ABC, then your latitude being 51 deg. 30 min. take it out of your line of Chords, and set it from B to E; and draw the line ED parallel to AB, cutting the line AC in D, then with the distance DE on the center A, describe the Quadrant GHR. Then supposing your Plain to decline 30 deg. set 30 deg. from B to F, in the Quadrant BEC, and draw the line FA cutting the Quadrant GHR in H, through which point H, draw the line SHN parallel to CA, and cutting the Quadrant BEC in N, so shall the arch CN be the height of the Pole above the Plain, and in this Example contains 32 deg. 37 min.

2. To find the deflexion, or the distance of the Substile from the Meridian.

Out of this figure take the distance HS, and set it in the line DE, from D to K; through which point K, draw the line AKL, cutting the Quadrant BC in L; so shall the arch CL be the distance of the Substile from the Meridian: and in this Example will be found to be 21 degrees 42 minutes.



CHAP. VI.

How to draw the Hour-lines upon an upright Plain declining from the Meridian towards the East or West.

WE will here take for Example a South erect Plain, declining Eastward 30 deg.

K

Having

Having (by the fifth Chapter of this Book) found the Deflexion of ſuch a Plain to be 21 deg. 42 min. and the height of the Stile (by the ſame Chapter) to be 32 deg. 37 min. we may proceed to draw the Dial in manner following.

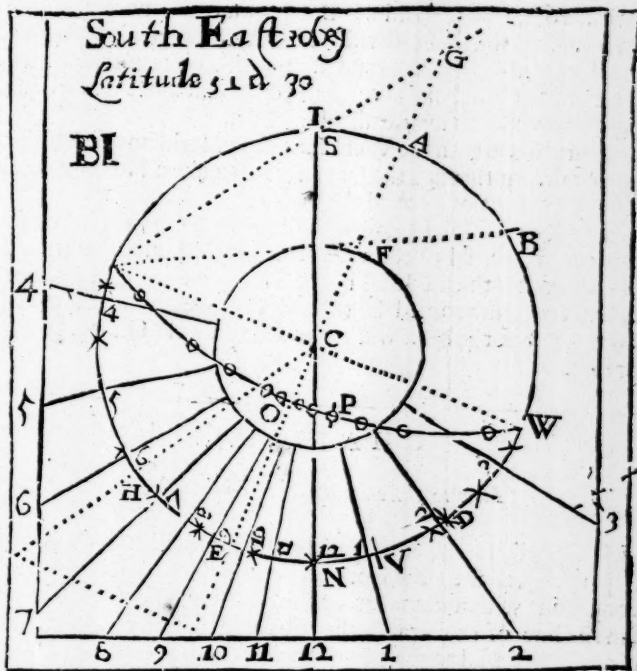
With the Radius of your line of Chords, on the Center C, deſcribe the Circle X N S W; and in it draw S N through the center C, for the Meridian, or line of 12. Then the deflexion being found to be 21 deg. 42 min. ſet that from N to E, and draw the line E C through the center to G; this line repreſenteth the Subſtilar line of your Dial, upon which line the Stile or Cock muſt ſtand. Alſo out from your line of Chords take 32 deg. 37 min. the height of the Stile, and ſet that diſtance from E to H, and draw the line C H for the Stile of your Dial; ſo ſhall the Triangle E C H be the true pattern for the Cock of your Dial.

The Subſtilar line E G being drawn, draw the line X W through the center C, and perpendicular to E G. This done, take the diſtance E H, (which is equal to the Stiles height) and ſet that diſtance from A to B, and from W to D. Likewiſe take the diſtance from W to B, and ſet it from B to I. Theſe three points I B, and D, being found in the Circumference of the Circle X N S W, lay a ruler from X to I, and it will cut the ſubſtilar line E C being extended in the point G, which is the Center upon which the Equinoctial Circle muſt be deſcribed. Again, a Ruler laid from X to B, will cut the ſubſtilar line in F; and a Ruler laid from X to D, will cut the ſubſtilar line in O. Now if you ſet one foot of your Compaſſes in G, and extend the other to X or W, you may deſcribe the Equinoctial Circle X O W, which (if you have not erred in your former Work) will paſs exactly through the point O in the ſubſtilar line before found. In the next place, if you lay a Ruler from F to N, it will cut the Equinoctial Circle in P; and a Ruler laid from C to P, will cut the Dial Circle in V.

Theſe things being performed, the next thing is to draw the hour lines, which will be eaſily effected, if you obſerve the former directions.

Fiſt, From the point V laſt found, begin to divide your hour Circle into 24 equal parts (or only one half of it into 12 parts) which you may do by taking 15 deg. out of your line of Chords, and

Set that distance on both sides of V at the marks *** &c. so many times as the Plain is capable of hours.



This done, If you lay a Ruler on the Center C, and every of these points *** &c. you shall divide the equinoctial Circle into 12 unequal parts in the points ●●●● &c. Now a Ruler laid from F to every of these unequal points ●●●● &c. will divide the hour-circle into twelve other unequal parts, marked with 4. 5. 6. 7. 8. 9. 10. 11. 12. 1. on the one side of V, and with 2. 3. on the other side of V.

Lastly, A Ruler laid from C to the several points, 4. 5. 6. 7. 8. 9. 10. 11. 12. 1. 2. 3. and lines drawn by the side thereof, they shall be the true hour lines belonging to such a declining Plain of 30 deg. in the Latitude of 51 deg. 30 min. But if you desire more hours than 12, the Equinoctial may be divided into more unequal parts, being continued beyond X and W, and if you will, quite round the whole Circle, but that is needless, without you would make 4 Dials in the making of one, as you may easily do. For,

The hours that are on the West side of the Meridian of a South-east Dial, being drawn through the Center, will make a North-west Dial of the same declination. And the hours on the East side of the Meridian of a South-west Dial, being drawn through the Center, will produce a North-east Dial of the same declination. And again, the real hour lines of a South-east Dial being drawn on the other side of the paper, and the hours named by their Complements to 12, that is, 10 for 2, 9 for 3, 8 for 4, &c. will make a South-west Dial of the same declination.

CHAP. VII.

How to place an upright Dial truly.

ALL upright Dials, in what latitude soever, have the Meridian perpendicular to the Horizon; wherefore to set your Dial exact, hang a line with a Plummet at the end thereof, and with a nail fixed in the line of 12 towards the top thereof, to hang the Plummet upon, apply the Dial to the place where it is to be fixed, so that the line and Plummet may hang just down upon the line of 12, neither inclining on one side or the other; the Dial thus fixed, if the declination were truly taken, and the Dial rightly made by the former directions, shall at all times (the Sun shining upon it) give you the true hour of the day.

CHAP. VIII.

How to insert the half and quarters of hours in all Dials.

THe halves and quarters of hours are drawn in all Plains by the same rules, and the like reason, that the hours are inserted. Therefore take notice that if you would insert the half hours into any Dial, you must divide your Equinoctial Circle into 24 equal parts instead of 12, and if you would insert the quarters, then you must divide it into 48 parts, and then proceed in all respects as you did for the whole hours.

CHAP. IX.

How to find the Declination of any upright Wall.

THe declination of a Plain is an arch of the Horizon comprehended between the Pole of the Plains Horizontal line, and the Meridian of the place.

To find this declination, two observations must be made, the Sun shining, and both at one instant of time (as near as may be.) The first is the Horizontal distance of the Sun from the Pole of the Plain. The second is the Suns Altitude.

First, To find the Horizontal distance. Apply the side of a Quadrant to your Plain, holding it (as near as may be) horizontal, that is to say, level; then holding up a thred and plummet, which must hang at full liberty, so that the shadow of the thred may pass directly through the center of the Quadrant, then diligently note through the degree of the Quadrant the shadow passed, and count those degrees from the side of your Quadrant which is perpendicular to the Plain, for those degrees are the Horizontal distance.

Secondly, At the same instant, take the Suns altitude, these two being heedfully taken, will help you to the Plains declination by the rules following.

By,

By the 17 or 18 Chapters of the second Book find the Suns Azimuth. Then observe whether the Sun be between the Pole of the Plains Horizontal line and the North or South points, or not.

If the Sun be between them, add the Azimuth and Horizontal distance together, and the sum of them is the declination of the Plain.

If the Sun be not between them, substract the lesser of them from the greater, and the difference shall be the declination of the Plain. These rules shew you the quantity of your Plains declination. But,

C H A P. X.

Shewing how to know whether your Plain decline from the Meridian towards either the East or West.

YOU must take notice in your observation, that if the Meridian point fall between the Azimuth and the Pole of the Plains Horizontal line, then doth the plain decline to the Coast contrary to that wherein the Sun is; that is to say, if the Sun be to the Eastward of the Meridian, the plain declines to the Westward: But if the Meridian point be not between the fore-mentioned distance and the Pole of the Plain, then doth the Plain decline to the same Coast in which the Sun was in the time of observation.

C H A P. XI.

Concerning Polar Dials.

A Polar Dial is made in all respects as an East or West Dial is made, only the line of 6 a Clock in the East or West Dial, is 12 a Clock in the Polar Dial, the hour of 7 is 1, of 8 is 2, of 9 is 3, of 10 is 4, and of 11 is 5. Also the hour of 5 in the East or West Dial, is 11 in the Polar, of 4 is 10, of 3 is 9, of 2, 8, 1 is 7, &c. The Cock of this Dial is a plate of Iron or Brass made of the breadth between

between 12 and 3 a clock, and set perpendicular upon the line of 12, as in the East or West Dial it is upon the line of 6. In these Dials the Equinoctial line is to lye parallel to the Horizon, and not to be elevated according to the complement of the latitude of the place, as in the East or West Dial it is.

C H A P. XII.

Concerning Equinoctial Dials.

AN Equinoctial Dial is of all other Dials the most easie to make, for if you describe a Circle, and divide it into 24 equal parts, and draw lines from the Center through every one of those equal parts, the lines so drawn shall be the true hour lines.

For the Stile of these Dials, it is no other but a straight Wyre of any length, set perpendicular in the Center of the Circle, whose shadow shall give the true hour of the day.

C H A P. XIII.

Of such plains as decline very far from the East or West towards the Meridian, as 75, 80 or 85 deg. above which Plains the Pole hath small Elevation.

Such Plains as decline above 60-degrees the hour lines will come very close together, so that if they be not extended very far from the Center, there will be no sensible distance between hour and hour.

To remedy this inconvenience, there are several ways, I will instance only in one, which is familiar and easie, and that is this.

When you have drawn your Dial on a large sheet of Paper, fix it on some large Table or smooth Floor of a Room, if the Dial you are to make be very large, as 5, 6, or 7 foot square, then by the side of

of a long Ruler laid to the Center and every hour-line, as also to the Stile and Substile, draw lines to the full extent of the Table or Flower, and you shall find them to be of a competent largeness. Then according to the bigness of your Plain cut off the hours, Stile and Substile, leaving the Center quite out, and your Work is finished.

CHAP. XIV.

Concerning Declining, Reclining and Inclining Dials.

WE should now shew the manner of drawing hour-lines upon declining, reclining and inclining Plains, of which there are several varieties, and many cautions, which in this place, and at this time would be too many to enumerate: but if this which hath been already delivered concerning Upright decliners shall be kindly accepted, it shall animate me to do the like for all other Plains whatsoever.

ALL sorts of Instruments belonging to the Art of Navigation, are to be sold by *John Sellers* living at the Sign of the *Mariners Compass* and *Sphere* at the *Hermitage* Stairs in *Wapping*; where you may be also instructed in the use of any of them, by the said *John Sellers*.

APPENDIX,

Containing the Use of

INSTRUMENTS.

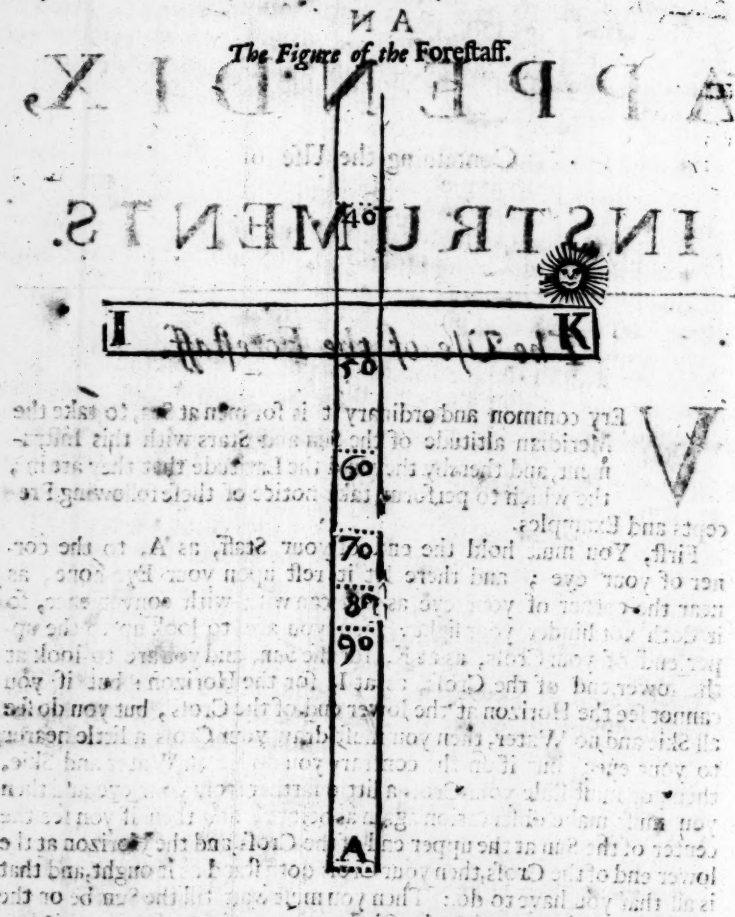
The Use of the Forestaff.

Very common and ordinary it is for men at Sea, to take the Meridian altitude of the Sun and Stars with this Instrument, and thereby they find the Latitude that they are in; the which to perform, take notice of these following Precepts and Examples.

First, You must hold the end of your Staff, as A, to the corner of your eye; and there let it rest upon your Eye-bone, as near the corner of your eye as you can with convenience, so it doth not hinder your sight: then you are to look up to the upper end of your Crofs, as at K, for the Sun, and you are to look at the lower end of the Crofs, as at I, for the Horizon: but if you cannot see the Horizon at the lower end of the Crofs, but you do see all Skie and no Water, then you must draw your Crofs a little nearer to your eye; but if on the contrary you do see all Water and Skie, then you must slide your Crofs a little farther from your eye, and then you must make observation again as before, and then if you see the center of the Sun at the upper end of the Crofs, and the Horizon at the lower end of the Crofs, then your Crofs doth stand as it ought, and that is all that you have to do: Then you must wait till the Sun be on the Meridian, and you must make Observation again as oft as your judgement shall think fit, and as you find the Sun to rise, you must draw your Crofs a little nearer to your eye; but if the Sun be fallen, then you

The Sea-mans Glas.

The Figure of the Forestaff.



minutes that the Cross doth stand at, is the Suns Meridian altitude.

Thus I have shewed you how to take an Observation by the Fore-staff: The next thing that followeth in course, will be to shew you how to work your Observation; which to do, take notice of these following Rules.

To work your Observation.

If the Sun hath North Declination, and be on the Meridian to the Southwards of you, then you must substract the Suns declination from your Meridian altitude, and the remainder is the height of the Equinoctial, or the complement of the Latitude North.

But if the Sun hath South Declination, you must add the Suns Declination to the Meridian altitude, and the Sum is the height of the Equator, or the complement of the Latitude North.

If the Sun hath North Declination, and be on the Meridian to the Northwards, then add the Suns declination to your Meridian altitude, and the sum is the height of the Equator, or the complement of the Latitude South, if the said sum doth not exceed 90 deg. but if it doth exceed 90 deg. you must substract 90 deg. from the said sum, and the remainder is your Latitude North.

If the Sun hath South Declination, and be to the Northwards at Noon, you must then substract the Suns Declination from his Meridian altitude, and the remainder is the complement of your latitude South.

When the Sun hath no Declination, then the Meridian altitude is the complement of the latitude.

If the Sun be in the Zenith, and if at the same time the Sun hath no Declination, then you are under the Equinoctial.

But if the Sun hath North Declination, and in the Zenith, then look how many deg. and min. the Declination is, and that is the latitude that you be in North.

But if your Declination be South, then you are so much in South latitude.

If you observe the Sun or a Star upon the Meridian beneath the Pole, then add your Meridian altitude to the complement of the Sun or Stars Declination, and the sum is the height of the Pole.

Rules for Observation in North Latitude.

Admit I am at Sea, and observe the Suns Meridian altitude to be

42 deg. 20 min. and at the same time the Suns Declination is 10 deg. 10 min. North, I demand the Latitude that I am in

<i>The Meridian altitude</i>	42 deg. 20 min.
<i>The Declination North Subst.</i>	10 10
<i>The complement of the Latitude</i>	32 10
	90 00
<i>The Latitude that I am in</i>	57 50 North.

Admit a Ship at Sea the 22 of May, Anno 1668. and I find the Suns Meridian altitude to be 65 deg. 10 m. I demand the Latitude.

<i>The Meridian altitude</i>	65 deg. 10 min.
<i>The Declination North Subst.</i>	22 15
<i>The complement of the Latitude</i>	42 55
	90 00
<i>The Latitude that I am in</i>	47 5

Admit a Ship at Sea the 27 day of Nov. Anno 1687. and I find the Suns Meridian altitude to be 26 deg. 30 min. I demand the Latitude that I am in.

<i>The Meridian altitude</i>	26 deg. 30 min.
<i>The Declination South Add</i>	22 44
<i>The complement of the Latitude</i>	49 14
	90 00
<i>The Latitude that I am in</i>	40 46

Admit a Ship at Sea the 25 day of April, Anno 1665. and I find the Suns Meridian altitude by observation to be 58 deg. 45 min. I demand the Latitude that I am in.

<i>The Meridian altitude</i>	58 deg. 45 min.
<i>The Declination North Subst.</i>	16 31
<i>The complement of the Latitude</i>	42 14
	90 00
<i>The Latitude I am in</i>	47 46

Admit a Ship at Sea the 12 day of June, Anno 1669. and I find the Suns Meridian altitude by observation to be 80 deg. 35 min. North. I demand the Latitude that I am in.

The Seaman's Glass.

77

The Meridian altitude N. 80 deg. 35 min.

The declination North Add 23 31

104 06

90 00

The Latitude that I am in 14 60 North.

Admit a Ship at Sea the 22 of *August*, Anno 1771. and the Suns Meridian altitude was observed to be 85 deg. 15 min. North. I demand the Latitude that I am in.

The Meridian altitude 85 deg. 15 min.

The Declination North Add 08 17

93 32

90 00

The Latitude that I am in 03 32 North.

Admit a Ship at Sea the 20 of *June* Anno 1657. and the Suns altitude was 66 deg. 45 min. North. I demand the Latitude that the Ship is in.

The Meridian altitude 66 deg. 45 min.

The Declination North Add 23 15 min.

90 00

90 00

The Ship is under the Equinoctial 00 00

Rules for observing the Stars.

Admit I am at Sea, and observe the *Bulls Eye* upon the Meridian, and I find his Meridian altitude to be 50 deg. 30 min. I demand the Latitude that I am in.

The Declination of this Star is 15 deg. 46 min. North.

The Meridian altitude 50 30

The Declination North, Subst. 15 46

Complement of the Latitude 34 44

90 00

The Latitude I am in 55 16 North.

Admit I am at Sea, and I observe the bright Star in the *Great Dogs* Mouth, and I find his Meridian altitude to be 35 deg. 45 min. I demand the Latitude that I am in.

The

The Sea-mans Glafs.

The Declination of this Star is	16 deg. 15 min. South.
The Meridian altitude	35 45
The Declination South Add	16 15
The height of the Equator	52 00
	90 00
The Latitude that I am in	38 00

Rules for Observation in South Latitude.

Admit a Ship at Sea the 10 day of *May*, Anno 1674. and I find the Suns Meridian altitude by observation to be 62 deg. 00 m. North. I demand the Latitude that the Ship is in.

The Meridian altitude North	62 deg. 00 min.
The Declination North Add	20 08
The complement of the Latitude	82 08
	90 00

The Latitude that the Ship is in 07 52 South.

Admit a Ship at Sea the 15 day of *January*, Anno 1692. and in Longitude 150 deg. East, and I find the Meridian altitude by observation to be 58 deg. 45 min. North. I demand the Latitude that the Ship is in.

The Declination in the Meridian of *London* for the 15 of *January* as abovesaid, is 18 deg. 37 min. the daily difference in Declination at this time is 15 min. therefore if you look in the Table of Proportion, you will find the proportional minutes to be 6 min. which you must add to the true declination in the Meridian of *London*, and the sum will be the true declination for the Longitude of 150 deg. East, which is 19 deg. 03 min.

The Meridian altitude North	58 deg. 45 min.
The Declination South, Subst.	19 03
The complement of the Latitude	39 42
	90 00

The Latitude that the Ship is in 50 18 South.

Admit a Ship at Sea the 12 day of *July*, Anno 1673. and I find the Suns Meridian altitude to be 66 deg. 52 min. North. I demand the Latitude.

The

The Meridian altitude North	66 deg. 62 min.	
The Declination North, Add	20	14
The complement of the Latitude	87	06
	90	00
The Latitude required South	02	54

Admit a Ship at Sea, the Suns declination being 15 deg. 30 min. South, and the Suns Meridian altitude 80 deg. 45 min. South, I demand the Latitude that the Ship is in.

Answer, 06 deg. 15. m. South.

Admit a Ship at Sea, the Suns declination being 11 deg. 14 min. South, and the Suns Meridian altitude 79 deg. 38 min. South, I demand the Latitude.

Answer, The Ship is in Latitude 00 deg. 52 min.

¶ Note, If you observe by the lower part of the Sun, you must add 16 min. for the Suns semidiameter, and the sum will be the true altitude of the Suns Center.

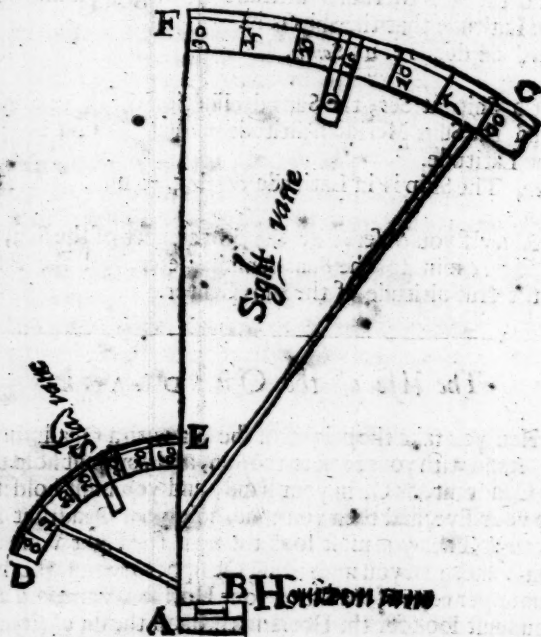
The Use of the QUADRANT.

When you take the height of the Sun with a Quadrant, you must stand with your back to the Sun, and you must hold the handle of your Quadrant, as C, in your hand, and you must hold the Sight-Vane to your Eye, and then you must hold your Quadrant as upright as you can: Then you must look through the Sight-Vane upon your Horizon-Vane, and you must bring the upper part of the shade to lye upon the upper edge of the slit on your Horizon-Vane; and at the same time you must look for the Horizon through the slit of your Horizon-Vane: But if you cannot see the Horizon, but you do see all Skie and no Water, then draw your Sight Vane a little lower down towards C: But if you see all Water and no Skie, then put your Sight-Vane a little higher up towards F, and when you have done so, observe again, and then if you see the shade lye upon the upper part of the slit on the Ho-

izon

The Sea-mans Glafs.

rizon Vane, and you at the same time do see the Horizon through the Sight Vane, then that is all that you have to do: Then you must wait till the Sun be on the Meridian, and you must bend the Sun, and make observation as often as your judgement shall think fit: But if the Sun

The Figure of the Quadrant.

be fallen, then when you go to observe again, you will not see the Horizon, for the Water will hide it from you, then you must not alter your Vanes; but you must let them stand as they were, and leave off observing: Then look what degrees do stand by the upper edge

edge of your shade Vane, which note, and look likewise what degrees stand against your sight, by your sight Vane; which add to the former degrees noted by the shade Vane, and their sum is the distance from the Zenith to the upper edge of the Sun, to which sum if you add 16 min. which is the Suns Semidiameter, you will have the true distance of the Suns Center from the Zenith, or the complement of the Meridian altitude: for if you observe by the upper part of the shade, then it is the upper limb of the Sun that gives the shade: But if you observe by the lower part of the shade, then it is the lower limb of the Sun that gives the shade. Therefore, if you observe by the upper part of the shade, you must add 16 min. but if you observe by the under part of the shade, you must subtract 16 min. to or from what your Instrument gives, and the sum or difference is the true distance of the Suns center from the Zenith.

Thus I have shewed you how to take an Observation with the Quadrant, I come now to shew you how to work your Observation. The difference that there is in working of an Observation taken by the Forestaff and the Quadrant, is only this. By the Forestaff you do take the altitude, but by the Quadrant you do take the complement of the altitude, or the distance of the Sun from the Zenith, but the altitude is the distance of the Sun from the Horizon, therefore if you do subtract the complement of the altitude from 90 deg. the remainr will be the altitude which you must use, as you were shewed in the use of the Forestaff.

But because it is usual to work Observations that are taken by the Quadrant, by the complement of the Suns meridian altitude, I will therefore give you some general Rules, and afterwards some particular Examples, and then I shall proceed to what followeth.

If the Sun hath North declination, and you in North Latitude, and the Sun upon the Meridian to the Southwards, then if you add the Suns declination to the Zenith distance, or complement of the Suns Meridian altitude, the sum will be the Latitude that you are in.

But on the contrary, If the Sun hath South declination, you must subtract the Suns declination from the Zeniths distance, and the remainer will be the Latitude that you are in.

If you be in South Latitude, and the Sun to the Northwards of you, then if the Sun hath South declination, you must add the Suns declin-

tion to the Zenith distance, and the Sum will be the Latitude that you are in South.

But if the Sun hath North declination, you must subtract the Suns declination from the Zenith distance, and the remainder will be the Latitude that you are in South.

¶ I might have been more large herein, giving you more general Rules: but if you understand those Rules that I have written for the use of the Fore-staff, you cannot err in using your *Quadrant*.

Admit a Ship at Sea the 10 day of April, Anno 1668. and I find the upper limb of the Sun to be distant from the Zenith 34 degrees 47 minutes; the Sun being upon the Meridian, I demand the Latitude that I am in.

Rules for Observation in North Latitude.

Complement of Meridian altitude	34 deg. 47 min.
The Suns Semidiameter	add 00 16
Distance of Suns center from Zenith	35 03
Declination North	add 11 55
Latitude that the Ship is in	46 58

A Ship at Sea the 12 of August, Anno 1672. and I find the Complement of the Suns Meridian altitude by observation to be 28 deg. 48 min. South, I demand the Latitude that the Ship is in.

Complement of Meridian altitude	28 deg. 48 min.
Suns Semidiameter	add 00 16
Distance of Suns center from Zenith	29 04
Declination North	add 10 52
The Latitude that the Ship is in	39 56

Admit a Ship at Sea the 13 day of Sept. Anno 1674. and I find the Complement of the Suns Meridian altitude by observation to be 47 deg. 35 min. I demand the Latitude that I am in.

Complement of Meridian altitude 47 deg. 35 min.

Suns Semidiameter add 00 16

Distance of Suns center from Zenith 47 51

Declination South subtract 00 13

Latitude that the Ship is in 47 38

Admit a Ship at Sea the 5 day of November, Anno 1665. and I find the Complement of the Suns Meridian altitude by observation to be 52 deg. 00 min. I demand the Latitude that the Ship is in.

Complement of Meridian altitude 52 deg. 00 min.

Suns Semidiameter add 00 16

Distance of Suns center from Zenith 52 16

Declination South subtract 18 34

Latitude that the Ship is in 33 31

Admit a Ship at Sea the 27 of May, Anno 1691. and I find the Sun to be to the Northward of me; and I find the complement of his Meridian altitude by Observation to be 10 deg. 15 min. I demand the Latitude that the Ship is in.

Suns Declination North 22 deg. 40 m.

Complement of Meridian altitude 10 15

The Suns Semidiameter add 00 16

The true Zenith distance subtract 10 31

Latitude that the Ship is in 12 18 N.

Admit a Ship at Sea the 29 day of June, An. 1695. and the Sun being upon the Meridian, I find by observation that the upper limb of the Sun is deg. 42 min. to the Northward of my Zenith, I demand the Latitude that I am in.

Suns Declination North 22 deg. 28 min.

Suns Semidiameter add 00 16

Suns suprem. marg. dist. from Zenith 06 42

Distance of Suns center from Zenith 06 58

Latitude that the Ship is in 15 28

A Ship at Sea the 21 of July, Anno 1682. and I am in Longitude 165 deg. West, and the Sun being upon the Meridian, I find by observation that the suprem. margine of the Sun is 16 deg. 45 min. to the Northward of my Zenith, I demand the Latitude that the Ship is in.

Declination North		18 deg. 15 min.
Proportional minutes..	subst.	00 06
Suns Declination in the Merid. given		18 09
Suns Supream marg. dist. from Zenith		16 45
Suns Semidiameter	add	00 16
Suns center distant from Zenith		17 01
Latitude that the Ship is in		01 08 N.

Rules for observation in South Latitude.

Admit a Ship at Sea the 15 day of July, *An.* 1691. and I am in Longitude 150 deg. *East*, and the Sun being upon the Meridian, I find the Complement of his Meridian altitude by observation to be 48 deg. 28 min. *North*, I demand the latitude that the Ship is in.

Complement of Meridian altitude		48 deg. 28 min.
Suns Semidiameter	add	00 16
Suns center distant from Zenith		48 44
Declination North	subtract	19 47
Latitude that the Ship is in		28 57 S.

Admit a Ship at Sea the 25 of Octob. *Anno* 1685. and in Longitude 120 deg. *West*, and the Complement of the Suns Meridian altitude by observation is 27 deg. 29 min. *North*, I demand the Latitude that the Ship is in.

Complement of Meridian altitude		27 deg. 29 min.
Suns Semidiameter	add	00 16
Suns center distant from Zenith		27 45
Declination South	add	15 46
Latitude that the Ship is in		43 31 S.

Admit a Ship at Sea the 24 of December, *Anno* 1694. and I find the Sun upon the South part of the Meridian, and I find by observation that the complement of the Suns Meridian altitude is 15 deg. 10 m. I demand the Latitude the Ship is in.

Complement of Meridian altitude	15 deg. 10 min.
Suns Semidiameter	add 00 26
Suns center from the Zenith	15 26
Declination South	22 45
Latitude that the Ship is in	07 19 S.

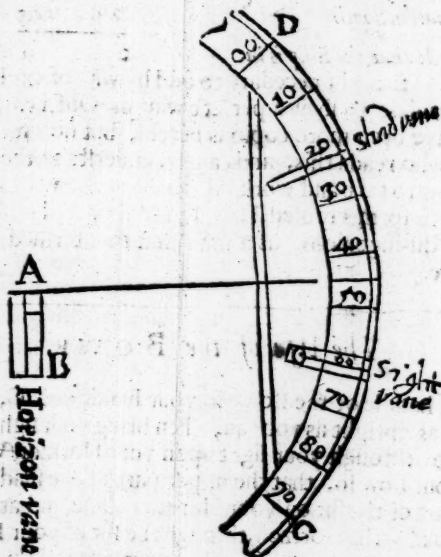
Thus much I thought necessary to add by way of explanation of the foregoing Tables, to shew a perfect way of Observation. I might, I confess, have been more copious herein, but not more plain; and that person who reads this, and cannot understand the use of the Tables, and how to take and work his Observation with more exactness than hath been formerly used, I say, I may very well rank such a person amongst the dis-ingenious, as a man unfit to intermeddle with things of this nature.

The Use of the BOWE.

TAKE the handle of the Bowe in your hand, viz. C, and hold your Bowe as upright as you can, then bring your sight Vane to your eye, and look through your sight upon your Horizon Vane, and you must hold your Bow so, that the upper part of the shade may lie upon the upper part of the slit on your Horizon Vane, and at the same time you must look for the Horizon, through the slit of your Horizon Vane. But if you cannot see the Horizon, but you do see all sky and no water, you must then draw your sight Vane a little lower down towards C. But if on the contrary, you do see all water and no sky, then slide your sight Vane a little higher up towards D, and then make observation again, and then if the upper part of the shade doth lie upon the upper part of the slit, and at the same time you do see the Horizon through your sight, and so through the slit of the Horizon Vane, then that is all that you have to do. Then you must wait and make observation as often as your judgment shall think fit, until such time as the Sun be on the Meridian; and if the Sun be to the Westwards of the Meridian, then you will perceive the Sun to be fallen, and then you will not see the Horizon when you observe, for the water will hide it from you, and then you have done observing for that time.

Then

Then look what degrees and minutes do stand against your sight at your sight Vane, which note, and look likewise what degrees do



stand by the upper part of the shade Vane; which subtract from the former degrees noted by the sight Vane, and the remainder is the Suns Meridian altitude, or the distance of the upper part of the Sun from the Horizon, from which if you subtract 16 minutes, which is the Suns Semidiameter, the remainder will be the distance of the Suns center from the Horizon, or the true Meridian altitude.

Now for to work your Observation, after you have the true Meridian altitude, you are to follow the same method that I have given you for the Forefall.

The use of the NOCTURNAL.

SEt the Tooth to the day of the Month, and hold it fast standing in that sort: Then lift up the Instrument, and hold it as upright as you can, only bow the uppermost part thereof so much towards you, until you may see the North Star through the hole in the center of the Nocturnal. Now when you see the North Star through the hole, then wind the Rule about, until by the cyphered edge of the Rule you may see the first of the Guards on the *Little Bear*; now if at the same time you see the North Star through the hole, and the first of the Guards on the *Little Bear*, by the edge of the Rule, then that is all that you have to do at that time. Then look by the edge of the Rule on the *Hour Circle*, and you will see the true hour of the Night. And see what point of the Compass the edge of the Rule standeth by, and that point sheweth you the bearing of the Guard Star from the North Star.

Example.

Admit the 10 day of February I observe at 7 a clock in the evening, I demand the Bearing of the Guard Star from the North Star.

If you look on the backside of the Nocturnal, you will find the edge of the Rule to stand against the North-east point, which is the point of Bearing desired.

¶ You are to take notice that you must always hold the Fore-side of the Nocturnal next your face.

Admit I observe the height of the North Star to be 42 deg. 10 min. and I find by the Nocturnal at the same time that it is a NE by N Guard, I demand the height of the Pole.

The Table that is in the 87 page in the *Sea-mans Kalender* sheweth, that when it is a NE by N Guard, the North Star is 1 deg. 3 min. above the Pole; therefore I subtract this 1 d. 3 min. from 42 d. 10 m. and the remainder is 41 d. 7 m. which is the height of the Pole desired.

Admit I observe the height of the North Star to be 45 deg. 22 m. and I find by the Nocturnal at the same time, that it is a SSE Guard, I demand the height of the Pole.

By the Table abovesaid, I find that with a *SSE* Guard the North Star is 2 deg. 29 min. under the Pole, therefore I add this 2 deg. 29 min. to 45 deg. 22 min. and the sum is 47 deg. 51 min. which is the height of the Pole desired.

The Use of GUNTERS LINES in NAVIGATION.

A Ship being in the Latitude of 43 deg. 30 min. North, she sails *SW* by *S*. 104 leagues, I demand the Latitude that she is in, and the departure from the Meridian.

Set one foot of your Compasses in 8 points and extend the other to 3 points, then set one foot in 104 in the line of numbers, and extend the other backward, and it will fall in 58 leagues, which is the departure from the Meridian: Then set one foot in 8 points, and extend the other to 5 points; then set one foot in 104 number, and extend the other backward, and it will fall in 86 Leagues, which is the difference of Latitude.

86 (4 d. 18 m.
20

43 d. 30 m. Latitude departed
4 18

39 12 Latitude the Ship is in.

A Ship being in the Latitude of 50 deg. 20 m. North, sails *NNW* 87 leagues, I demand the Latitude that she is in, and the departure from the Meridian.

Set one foot in 8 p. and extend the other to 2 p. then set one foot in 87 N. and extend the other backward, and it will fall in 33 leagues, which is the departure from the Meridian. Then set one foot in 8 p. and extend the other to 6 p. then set one foot in 87 N. and extend the other backward, and it will fall in 80 leagues, which is the difference of Latitude

80 (4 d. 00 m. 50 d. 20 m. Latitude departed

20

4 00

54 20 Latitude the Ship is in.

A Ship being in the Latitude of 51 deg. 15 m. North, she sails SE b S, until she be in the Latitude of 46 deg. 45 min. I demand the distance run, and the departure from the Meridian.

Set one foot in 8 p. and extend the other to 5 p. then set one foot in 90 n. and extend the other forwards, and it will fall in 109 leagues, which is the distance run.

Set one foot in 5 p. and extend the other to 3 p. then set one foot in 90 n. and extend the other backward, and it will fall in 60 leagues, which is the departure from the Meridian.

A Ship being in the Latitude of 48 deg. 00 m. North, she sails between the South and the East until she be in the latitude of 42 deg. 30 m. and till her distance run be 134 leagues: I demand the Course that she hath sailed, and the departure from the Meridian.

Latitude departed	48 deg. 00 min.
Latitude she is in	42 30
Difference of Latitude	05 30
Leagues	110

Set one foot in 134 N. and extend the other to 110 N. then set one foot in 90 lines, and extend the other backward, and it will fall in 55 deg. 00 min. lines, which is the complement of the course; therefore the course is 35 deg. 00 min. from the South-east wards.

Set one foot in 90 d. line, and extend the other to 35 d. line, then set one foot in 134 N. and extend the other backward, and it will fall in 77 N. which is the departure from the Meridian.

A Travis.

A Ship being in the latitude of 40 d. 00 m. North, she sails SE b S 68 miles, and then sails SW b S 55 miles, and then sails WNW 73 miles; I demand the course and distance sailed from the first place of departure.

Set one foot in 8 p. and extend the other to 3 p. then set one foot in 68 n. and extend the other backward, and it will fall in 38 N. which is in the Easting in the first course.

Set one foot in 8 p. and extend the other to 5 p. then set one foot in 68 n. and extend the other backward, and it will fall in 56 N. which is the Southing of the first course.

Next set one foot in 8 p. and extend the other to 5 p. then set one foot in 55 N. and extend the other backward, and it will fall in 45 N. which

which is the Westing in the second course. Set one foot in 8 p. and extend the other to 3 p. then set one foot in 55 n. and extend the other backward, and it will fall in 30 n. which is the Southing in the second course. Set one foot in 8 p. and extend the other to 6 p. then set one foot in 75 n. and extend the other backward, and it will fall in 69 n. which is the Westing in the third course. Then set one foot in 8 p. and extend the other to 2 p. then set one foot in 75 n. and extend the other backward, and it will fall in 28½ n. which is the Northing in the third course.

North	South	East	West
28½	56	38	45
	50	14	69
	<hr/>	<hr/>	<hr/>
	86	76 degt.	114
	<hr/>		<hr/>
	28½		

57½ difference of Latitude.

Set one foot in 76 n. and extend the other to 57½ n. then set one foot in 45 d. tan. and extend the other backward, and it will fall in 53 deg. 00 min. tan. which is the course from the Southwestward, viz. SW 8 d. West. Set one foot in 90 line, and extend the other to 53 d. line, then set one foot in 76 n. and extend the other forward, and it will fall in 96 n. which is the distance run from the first place of departure.

37 (2 d. 42 min. 40 d. 00 m. Latitude departed
20 2 52 Diff. of Latit. Sub.
37 08 Latit. the Ship is in.

A Ship being in the Latitude of 50 deg. 10 m. North, and in Longitude 5 d. 24 m. West, she sails first SSE 72 miles, and then sails WSW 45 miles, and then sails EbN 67 miles, and then sails NNE 85 miles, and then sails WSW 40 miles, now I demand the course and distance sailed from the first place of departure? likewise the latitude and longitude that the Ship is in.

1 Course

1 Course	8 p	2 p	72 n	27 $\frac{1}{2}$ n	East
	8 p	6 p	72 n	66 n	South
2 Course	8 p	6 p	45 n	41 n	West
	8 p	2 p	45 n	17 n	South
3 Course	8 p	7 p	67 n	65 $\frac{1}{2}$ n	East
	8 p	1 p	67 n	13 n	North
4 Course	8 p	2 p	85 n	32 n	East
	8 p	6 p	85 n	78 n	North
5 Course	8 p	6 p	40 n	36 $\frac{1}{2}$ n	West
	8 p	2 p	40 n	15 n	South

North	South	East	West
13	66	27	19
78	47	65	36
<u>91</u>	<u>15</u>	<u>32</u>	<u>77</u>
	98	125	

Northung	Saathing	Eastung	Westung
Saathing	98	Eastung	935
Northung	991	Westung	773
Differ. of Lat.	07	Departure	1474

Set one foot in $47\frac{1}{2}$ n. and extend the other to 7 n. then set one foot in 45 d. tan. extend the other backward, and it will fall in 81 d. 36 m. tan. which is the course from the South Eastwards, viz. E by S $\frac{1}{2}$ E. Set one foot in 90 deg. fine, and extend the other to 81 d. 36 m. line, then set one foot in $47\frac{1}{2}$ n. and extend the other forward, and it will fall in 48 n. which is the distance run from the first place of departure.

The Latitude departed	50 deg 10 m
Difference of Latitude	ca 807
The Latitud. the Ship is in	50 03
	<hr/>
	100 13
The middle Latitude	50 6

Set one foot in 90 deg. line, and extend the other to 39 deg. 54 m. line, then set one foot in $47\frac{1}{2}$ n. and extend the other forward, and it will fall in 74 n. which is the difference of longitude in miles.

Longitude departed

5 deg. 24 m.

Difference of Longitude

1 1+

The Longitude, the Ship is in

4 10 West.

Note, If you be in West Longitude, and sail to the Eastward, you must subtract your difference of Longitude from your Longitude departed, and the remainder is the Longitude that the Ship is in: But if you sail to the Westward, you must add your difference of Longitude to the Longitude departed, and the Sum is the Longitude that you are in: But if you be in the East Longitude, then sailing to the Eastward, your Longitude increaseth, and sailing to the Westward, your Longitude decreaseth.

A Ship being in the Longitude of 41 deg. 30 m. North, and in Longitude 10 deg. 20 min. East, she first sails S E by S 52 miles, and then sails S S W 63 miles, and then sails E by N 47 miles, and then sails N by E $\frac{1}{2}$ E 35 miles, and then sails N N W $\frac{1}{4}$ W 67 miles, and then sails W N W 73 miles. Now I demand the course and distance sailed from the first place of departure, likewise the Latitude and Longitude that the Ship is in.

	M.	P.	P.	N.	N.		M.	P.	P.	N.	N.
S E by S	52	8	3	52	28 $\frac{1}{2}$	E	8	5	52	43	S
SSW	63	8	2	63	24	W	8	6	63	58	S
E by N	47	8	7	47	46	E	8	11	47	09	N
N E by E $\frac{1}{2}$ E	35	8	5 $\frac{1}{2}$	35	31	E	8	2 $\frac{1}{2}$	35	16 $\frac{1}{2}$	N
NNW $\frac{1}{4}$ W	67	8	2 $\frac{1}{2}$	67	28 $\frac{1}{2}$	W	8	5 $\frac{1}{4}$	67	60	N
WNW	73	8	6	73	67	W	8	2	73	27 $\frac{1}{2}$	N

North

North	South	East	West
9	43	28 $\frac{1}{2}$	24
16 $\frac{1}{2}$	51	46	28 $\frac{1}{2}$
60		31	67
27 $\frac{1}{2}$	101 South		
		105 $\frac{1}{4}$ Easting	119 $\frac{1}{4}$ Westing
113 Northing			105 $\frac{1}{2}$
101			
			13 $\frac{1}{4}$
12 diff. Latitude			depart. Merid.

Set one foot in 12 n. and extend the other to 13 $\frac{1}{4}$ n. then set one foot in 45 deg. tan. and extend the other backward, and it will fall in 48 deg. 50 min. tan. which is the course from the North Westward, viz. NW 3 deg. 50 min. West. Set one foot in 90 d. sine, and extend the other to 48 deg. 50 min. sine, then set one foot in 13 $\frac{1}{4}$ n. and extend the other forward, and it will fall in 18 $\frac{1}{4}$, which is the distance run from the first place of the departure.

Latitude departed 41 deg. 30 m.
Difference of Latitude 00 12

Latitude the Ship is in 41 42

Middle Latitude 41 36

Set one foot in 90 deg. sine, and extend the other to 48 d. 24 m. sine, then set one foot in 13 $\frac{1}{4}$ n. and extend the other forward, and it will fall in 18 $\frac{1}{4}$ n. which is the difference of Longitude in miles.

Longitude departed 10 deg. 20 m.
Difference of Longitude 0 18

Longitude the Ship is in 10 02

The Use of GUNTERS LINES in measuring OF BOARD and TIMBER.

Admit a Board to be 10 inches broad, and 20 foot long, I demand the Content.

Set one foot in 12, and extend the other to 10, then set one foot in 20, and extend the other backward, and it will fall in 16 foot and a half, which is the content of the Board required.

Admit a Board to be 15 inches broad, and 27 foot long, I demand the content.

Set one foot in 12, and extend the other to 15, then set one foot in 27, and extend the other forward, and it will fall in 34 foot, which is the content required.

Admit a Board to be $7\frac{1}{2}$ inches broad, and 29 foot long, I demand the content.

Set one foot in 12, and extend the other to $7\frac{1}{2}$, then set one foot in 29, and extend the other backward, and it will fall in 18 foot; which is the content required.

Admit a Board to be 27 inches broad, and 9 foot and a half long, I demand the content.

Set one foot in 12, and extend the other to 27, then set one foot in $9\frac{1}{2}$, and extend the other forward, and it will fall in $21\frac{1}{4}$ foot; which is the content required.

Admit a piece of Timber to be 8 inches square, and 20 foot long, I desire to know how many square foot there is contained in this piece of Timber.

Set one foot in 12, and extend the other to 8, then set one foot in 20, and extend that distance twice backward, and it will fall in 8 foot 3 quarters, which is the content required.

Admit a piece of Timber to be $9\frac{1}{2}$ inches square, I demand the content.

Set

Set one foot in 12, and extend the other to 9 $\frac{1}{2}$; then ſet one foot in 27, and extend that diſtance twice backward, and it will fall in 17 foot; which is the content required.

Admit a piece of Timber to be 18 inches ſquare, and 9 foot long, I demand the content.

Set one foot in 12, and extend the other to 18; then ſet one foot in 9, and extend that diſtance twice forward, and it will fall into 20 $\frac{1}{2}$ foot; which is the content required.

Admit a piece of Timber to be 22 inches ſquare, and 35 foot long, I demand the content.

Set one foot in 12, and extend the other to 22; then ſet one foot in 35, and extend that diſtance twice forward, and it will fall in 118 foot; which is the content required.

The Uſe of the SECTOR in Navigation.

A Ship being in the Latitude of 42 deg. 20 min. North, ſhe ſails NE b N 104 leagues, I demand the Latitude that ſhe is in, and the departure from the Meridian.

Fiſt take the half of 104, which is 52, from the Line of Lines, then ſet one foot in 90 deg. ſines, and open the Sector till the other foot toucheth 90 deg. ſines on the other part of the Sector, and there let the Sector ſtand; then ſet one foot in 33 deg. 45 min. ſines, and extend the other to 33 deg. 45 m. ſines, and meaſure that diſtance on the line of lines, and it will be 29, the double of it is 58 leagues, which is the departure from the Meridian. Set one foot in 56 deg. 15 min. ſine, and extend the other to 56 deg. 15 min. ſine, and meaſure that diſtance on the line of lines, and it will be 43 $\frac{1}{2}$, the double of it is 87 leagues, which is the difference of Latitude.

87 (4 d. 21. m.
20

42 d. 20 m. Latitude departed.
4 21 Difference add

46 41 Latit. the Ship is in.

A Ship being in the Latitude of 43^d deg. 10 min. North, ſhe ſails S S W 87 miles; I demand the Latitude that ſhe is in, and the departure from the Meridian?

Take 87 from the line of lines, and with that diſtance ſet one foot in 90 deg. line, and extend the other to 90 deg. line, then let the Sector ſtand: Then ſet one foot in 22 d. 30 m. ſine, and extend the other to 22 d. 30 m. ſine, and meaſure that diſtance upon the line of lines, and it will be 33 miles, which is the departure from the Meridian. Then ſet one foot in 67 deg. 30 m. ſine, and extend the other to 67 deg. 30 m. ſine, then meaſure that diſtance upon the line of lines, and it will be 80 miles, which is the difference of Latitude.

80 (1 d. 20 m.
60

43 d. 10 m.
1 20

Latitude departed
Difference ſubſt.

41 50

Latit. the Ship is in.

A Ship being in the Latitude of 51 deg. 15 min. North, ſhe ſails S W by S, until ſhe be in the Latitude of 46 deg. 45 min. I demand the diſtance run, and the departure from the Meridian.

Take 45 from the line of lines, and ſet one foot in 56 deg. 15 m. ſine; and open the Sector till the other foot touch 56 deg. 15 m. ſine, then let the Sector ſtand: then ſet one foot in 90 deg. line, and extend the other to 90 deg. line, and meaſure that diſtance on the line of lines, and it will be 54, the double is 108 leagues, which is the diſtance run.

Then ſet one foot in 33 deg. 45 min. ſine, and extend the other to 33 deg. 45 m. ſine, and meaſure that diſtance on the line of lines, and it will be 30, and the double is 60 leagues, which is the departure from the Meridian.

